LEED DOCUMENTATION PROCESS:

IMPLEMENTATION BARRIERS FOR SCHOOL PROJECTS

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(ABSTRACT)

The Center for High Performance Learning Environments (CHPLE) at Virginia Tech aims to provide guidance on various issues associated with high performance learning environments, using information gained through the various studies undertaken at the College of Architecture and Urban Studies. One such study is presented in this thesis. Leadership in Energy and Environmental Design (LEED), an environmental rating system for buildings, introduced in 1998, is still in the process of development. The USGBC conducted research and introduced various LEED manuals for different building types. For each building type, in order to achieve environmental credits under LEED, evidence must be provided in terms of various documents. The process of collecting and submitting these documents is perceived to be difficult and this study tries to find the barriers to the documentation process as required during LEED certification. Currently, while documenting the credits under LEED, the design team must assume many important responsibilities. Hence this research sought participation from this group of professionals, who are proactive in promoting LEED and also have experience in school design.

To understand the design professional's perception about LEED, a semi-structured interview method was adopted to obtain data for this study. Out of a total of 175 invitations, 15 agreed to participate. A questionnaire was developed and the participants were asked to respond. All interviews were recorded, providing the main source of data. IRB approval was obtained prior to the interviews and all the prescribed ethical concerns were addressed during the interviews.

The responses to the questionnaire, were categorized as,

1. Barriers for documentation and

2. Recommendations from participants for improving the LEED documentation process.

The identified barriers were sequenced to understand the interrelationships between different barriers. The recommendations are interpretations and derivations of the participant recommendations. These recommendations could be adopted by the USGBC to improve the process of documentation in LEED. This study may also initiate other studies to help further understand the opinions of school authorities and other project members with respect to LEED documentation.

ACKNOWLEDGEMENTS

Similar to any study, this thesis required the support of many people other than the researcher. Although it is a rewarding feeling to have my name on a thesis book, it would be selfish to forget those individuals who have been supportive of my work and I would like to take this opportunity to thank them.

Dr. James Jones, my committee chair, deserves special recognition for his guidance throughout my research. He suggested the need for this study and constantly encouraged me with his intellectual advice. As the Director of CHPLE, he is highly committed to all the research under the umbrella of the organization. His support was essential for exploring various aspects of this research.

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Finally, my husband, Manan Gupta, who has been my strength through "thick and thin," unselfishly, supporting me all the way long. To him I dedicate this research.

If I have missed out on expressing my gratitude to any who have been part of my journey though this research, I give my regrets and say thank you to anyone who helped me along the way.

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CHAPTER 1 INTRODUCTION

Center for High Performance Learning Environments (CHPLE)

According to the U.S. Environmental Protection Agency (EPA), 53 million children and 6 million adults spend a good amount of time each day in almost 120,000 school buildings. The planning of the spaces, lighting conditions, outdoor accessibility, and many other factors become crucial as it affects the health and performance of the occupants in these buildings. From the school authority's standpoint, cost and maintenance are among the central issues. Many school districts are facing the additional burden of constructing more schools due to the boom in the student population. With the average age of a school building at 40 years, many old schools need to be replaced. In the next few years, the annual school construction industry cost is projected to increase from an average of $30 million to $100 million. To add to the woes of the school authorities is the increasing cost of energy over the coming years. School districts, by and large, are conservative in their planning approach, but recent increases in fuel costs have started many decision-makers thinking about looking for non-conventional solutions.

The Center for High Performance Learning Environments at the College of Architecture and Urban Studies at Virginia Tech is a first-of-its-kind resource for designers, engineers,

system consultants, teachers, school administrators, facility managers, and others interested in enhancing K through 16 learning environments. Several groups within the CHPLE are working on projects that focus on energy efficiency, sustainability, systems integration, and integrating appropriate technology for classrooms of the 21st century. The thesis was conducted through the CHPLE.

Leadership in Energy and Environmental Design

The Leadership in Energy and Environmental Design Reference Guide is a rating system which grades buildings for their overall environmental performance. The reference guide is divided into environmental categories with weighted importance such as, sustainable sites (22%), water efficiency (8%), energy and atmosphere (27%), materials and resources (20%), indoor environmental quality (23%), and innovation and design process. Under each category there are guidelines addressing environmental concerns, which the design and construction team must try to achieve. There is a credit associated with each guideline and the more the number of credits a building accomplishes, the better it achieves environmental design objectives according to LEED. The rating scale of 0 – 69 points is classified at four levels: platinum (52 points or more), gold (39 to 51 points), silver (33 to 38 points), and certified (26 to 32 points) – in descending order of environmental sensitivity. The guidelines under each category are tabulated in ***Table 13*** – ***Appendix A***.

The U.S. Green Building Council (USGBC) is the organization which developed the LEED rating system in 1998. Since its inception, LEED has undergone revisions (version 1.0, 2.0, 2.1, and 2.2) to address changing environmental issues and to simplify the method of evaluation. The USGBC acts as a third party, assessing the building of the applicant project team, based on LEED guidelines and then rates it. At present LEED is being modified to incorporate the long-standing demand of the architectural and engineering community and, to have separate guidelines with respect to the *functional typology* of buildings. Until now the USGBC has released LEED for New Construction, LEED for Existing Building Operations, LEED for Commercial Interiors, LEED for Core and Shells, and LEED for Homes: LEED for Neighborhood Development is in its pilot test stage. There is also a proposal to develop LEED for Schools.

Co-Relating LEED and the CHPLE

In anticipation of the USGBC's development of LEED for Schools, the research group at the CHPLE, which is already engaged in the study of high performance learning environments, initiated an investigation into the applicability of LEED guidelines for schools. During the course of study, the investigating team realized that the inquiry into the LEED Reference Guide cannot be concentrated only on design guidelines, but must include concerns for the process of documentation. Even if the environmental directives outlined in the guidebook are fulfilled, before receiving credit for their efforts, the project team must prove design objectives have been met through elaborate documentation. In many cases the documentation for LEED has discouraged designers and school administrators from continuing the pursuit for certification. Through this study the barriers to the LEED documentation process will be better understood.

The investigating team had two related objectives in their research, with both studies undertaken simultaneously. One objective was to better understand the applicability of the LEED rating system to schools while the second was focused on identifying the barriers to the documentation process, also as they relate to school design. The thesis presented in this book concentrates on the study of the implementation barriers for school projects in the LEED documentation process.

Documentation Process in LEED

As an evaluation model the required documentation for LEED certification attracted criticism from various stakeholders within the building industry. The opponents of LEED have made the documentation process one of the targets for attacking the rating system and the proponents also consider it to be one of the shortcomings of LEED. Recognizing the pressure for modification in the evaluation method, the USGBC took steps to improve the process.

The very first LEED Reference Guide version 1.0 required the submission of all the documents collected to provide evidence for obtaining the credits. With version 2.0, the USGBC made improvements in the guidelines, but there was little difference in the process

of documenting each credit. The release of LEED version 2.1 saw considerable changes in the requirements for evaluation. For many of the credits, an Excel sheet template was made available which included the necessary documents to apply for the credit. This letter template had to be signed by the person managing the project work under that credit and include a brief description of how the requirements had been met. The letter template was created to ensure that only the required documents be submitted, streamlining the application review process. But random audits were still carried out to uphold the integrity of third-party evaluation of LEED. Even after these modifications, concerns were raised about the elaborate paperwork and imprecise document requirement.

The latest LEED version, 2.2, launched during the November 2005 Atlanta Greenbuild Conference, is an attempt to reduce the paperwork. Instead of the letter templates, all the credits are submitted online. Details about the credits can be managed online and it is also possible to communicate with the reviewers or request clarification of credits. The credit templates has data fields in which the design team must record the information for documentation with options available for alternate compliance paths for the credits. The submission of documents can also be made in two phases – design phase and construction phase. The credits, irrespective of the category they belong to, are accordingly associated with one of these two phases. The design phase guidelines only receive anticipatory credits and the final credit is achieved only after the documentation for the entire project is submitted.

With version 2.2, LEED has taken a big leap in the direction of reducing paperwork and streamlining the requirements. Version 2.2 has been introduced only recently and any comment on the improvements is not possible unless it has been used by a project team. The USGBC made this transformation in LEED after conducting a market survey of its users from architecture, engineering, construction and building ownerships.

Utilizing a survey as an instrument to collect data for the research was common to both the studies conducted by the USGBC as well as the research team at the CHPLE. But, unlike USGBC, the scope of survey for the research at the CHPLE was focused only on the design

team of LEED registered school projects because the ultimate goal of this study is to have environmental guidelines and documentation procedures appropriate to schools.

Problem Statement

The research is a response to comments from LEED professionals who suggested that even if school authorities are interested in getting their building LEED registered, the documentation process is a formidable barrier to its implementation for their project. Often it seems that the design team, in particular, is willing to continue with the certification process, but has to yield to the owner's wishes to discontinue the pursuit of LEED certification. Although these were informal comments heard from architects, the frequency at which the complaint was heard resulted in the initiation of a study to assess the validity of those statements.

Hence, the hypothesis for this research can be stated as follows: "The process of documentation for achieving credits in LEED in its present form discourages owners and design teams of public school projects from pursuing certification even after following the environmental guidelines."

The researcher made a sincere attempt to justify this statement. USGBC could take heed of this study and compare the findings with the results of their survey. This research has the authenticity of being a third party survey.

Objectives of the Research

The study would like to give the school design teams an opportunity to voice their thoughts about LEED and express their ideas, which are categorized in the objectives below.

- This study aims to find the difficulties faced by the design team in the existing model of the documentation process for school projects. It also aims to find the barriers faced in the individual categories of the LEED Reference Guide.

- The researcher seeks suggestions from the design team members experienced in school design to make modifications and improvements in the process of documentation, hence making it appropriate for encouraging environmentally

responsible schools. The design team could also recommend additions to the certification process that would contribute towards a better learning environment.

- The study also attempts to obtain the opinions from the design team members for borrowing methods of evaluation from other rating systems that would enrich and strengthen the evaluation technique of LEED.

Contribution to the Body of Knowledge

The advent of LEED for schools will advance the efforts of the USGBC to make the building industry more sensitive to environmental issues. With evaluation techniques specially framed for high performance learning environments, will persuade a new category of building type to adopt LEED.

This study also provides an opportunity to the architectural community of school designers to put forth their opinions. The suggestions from this study can be incorporated in the evaluation method of school projects and also other building types when applicable.

In planning a school, the school district and the community are actively involved with the architects. Simplifying documentation can encourage the involvement of school designers in environmentally responsive schools who, in turn, can promote environmentalism to the school authorities and communities. This can make communities aware of and sensitive to environmental issues.

Limitations of the Study

This study relies on a qualitative method of research wherein the most important potential limitation is that the researcher is the instrument of evaluation. It is solely dependent on self-reporting.

The data for the research is reliant on the views of the participants, which are then interpreted as understood by the researcher. This retrospective collection of data is another important limitation of this study.

The invitation for participation was sent to several relevant practitioners, but only a selected section expressed a willingness to participate. This limited the sample size of participants. Fortunately the willing participants had a demographical diversity.

Although LEED has its applicability at an international level, this study restricted the selection of participants to the boundaries of the U.S., so the views expressed by the participants may not be appropriate to apply beyond the defined boundaries. The study can be used as a reference for a similar study which could focus on areas beyond the U.S.

Only the designers of school projects were involved in this research.

Definition of Terms

Definition of terms pertaining to this book:

Assessment, Evaluation: The method adopted by the reviewing committee for verifying the submittal. The method of assessment is different for different rating systems.

Documentation: The exercise of assembling and systematically recording the paperwork that provides evidence for qualifying for a credit.

Functional Typology: The distinction of a building from another based on its type of occupancy and usability.

LEED Certified: An award or approval given to a building for its environmental performance based on the LEED guidelines.

Review Committee, Assessor: An individual or a group of individual qualified professionals from the building industry who are authorized to review the submittal to verify the claims made in the application for certification.

Submittal: The final report prepared for LEED certification review as a culmination of the documentation process.

Sustainability: An architectural property of a program which allows continued viability. – Open Knowledge Initiative, Massachusetts Institute of Technology.

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Chapter Summary

In this chapter we discussed the origin of the problem, the relevance for undertaking this study with the specific objectives behind it, and the contribution of this study to the body of knowledge. It also discussed the limitations of this study and, finally, listed the definition of terms used in this book.

CHAPTER 2 LITERATURE REVIEW

Evaluation Methods in Various Prevalent Environmental Rating Systems

In the 1970s, a handful of designers initiated the effort to incorporate environmental issues in their building designs. They followed self-imposed guidelines while designing. At a global level sensitivity towards environmental issues was growing with various industries endorsing sustainability and governments of several countries actively involved in drafting energy policies. With a scenario apt for introducing environmental issues, during the 1990s individuals from the construction industry came together to form organizations to promote sustainability and energy efficiency in design. The Building Research Establishment Limited (BRE) of the U.K., the U.S. Green Building Council (USGBC), Natural Resources Canada and International Initiative for Sustainable Built Environment (iiSBE) were some of the organizations which were established. As part of their efforts to promote environmental sensitivity in the construction industry, these organizations developed rating systems to rank buildings for their environmental performance. The Environmental Protection Agency, a government body, also developed guidelines to encourage awareness amongst the building community. Large design firms and local authorities even developed their own environmental design guidelines.

In the various rating systems the environmental issues often overlap to a large extent, but each system have their distinctive method of evaluation with some similarities. Most of these rating systems started with a set of guidelines applicable for evaluating any building irrespective of the type of occupancy. Designers are currently in the process of developing guidelines specific to occupancy types. This chapter is an attempt to understand various rating systems and compare them to LEED.

BRE's Environmental Assessment Method (BREEAM)

Introduction to BRE and BREEAM: BREEAM is an environmental rating system mainly prevalent in the U.K. and to some extent in the countries in the European Union. It was developed in the 1990s by Building Research Establishment Ltd. (BRE) in the U.K. and is believed to be the first rating system for assessing buildings based on environmental issues. To review BREEAM it is first essential to understand the contribution of BRE to the building industry.

BRE was founded in 1921 to initiate advancements and improvements in building environments. It is involved in certifying and testing the built environment for its quality of space and environmental consciousness, providing consultancy for the use of new technologies, research in areas associated with building regulations in the U.K., fire safety issues, structural integrity and building-occupant interaction, and training people on a wide range of topics associated with the built environment.

One of the major contributions of BRE to the building industry was the creation of BREEAM for rating buildings for their environmental performance. BRE gradually launched BREEAM for various building sectors which include offices, retail buildings, hospitals, homes, schools and infrastructure. BREEAM Schools, introduced in 2005, is a recent induction to the family of rating systems. It was launched in response to the "Sustainable Development Action Plan" for schools by the Development for Education and Skills (DfES) of the U.K. Government. It is applicable to both new as well as refurbished school projects. Nine environmental categories are identified in the compliance manual for schools which are

stated in ***Table 1***. The building is rated for its performance in each category and then summed to get an overall score. Based on the overall score the building is rated.

There are four levels of rating.

- Pass – 25 to 39 points
- Good – 40 to 54 points
- Very Good – 55 to 69 points
- Excellent – 70 points and more

According to DfES, all new and renovation projects in schools should have at least a ”very good” BREEAM rating, if the primary school project will cost more than £500,000 and the secondary school project will cost more than £2 million.

Method of Assessment: Although BRE is the developer of BREEAM, it is not in direct contact with the users of their product. It is only the technical brain behind the product; the actual assessment and marketing is done by the assessment organizations. The ”Assessment Organizations” are licensed by BRE to conduct assessments of buildings applying for BREEAM certification. These organizations comprise ”Assessors” who have to undergo training at BRE to be qualified to conduct these inspections. The ”Assessors” are the people in actual contact with the clients and the design team.

The Assessor provides pre-assessment consultancy to the design team if required. The actual assessment is only a meeting between the Assessor and the design team, which is preferably conducted as the project nears completion. Two weeks prior to the Assessment Meeting the Assessor sends the “Information Required Schedule” to the design team. During the meeting, the Assessor inspects all the details provided and may also carry out onsite inspection. He/She compiles the findings and the predicted level of grading for the project in an ”Assessment Report.” The report also includes the information given verbally, in writing, and observed on site. Even the strengths and weaknesses of the building are included in the ”Assessment Report.”.

The report is then submitted to BRE which carries out quality assurance of the findings and sends back the report to the assessor for amendments, if required. After the review is completed, the school project is issued a certification by BRE based on the recommendations of the assessor. The assessment report can then be handed to the clients of the concerned project. BRE demands that the assessment organization archive the report for the period of 10 years at least, along with the telephone conversation records, correspondence, notes of meetings, assumptions made and any other important information related to the project. These documents can be used as research material by BRE for refining the BREEAM School's compliance manual.

In the BREEAM rating system the onus of carrying out the work falls on the assessors and the assessment organization. They have to attend to the clients on a day-to-day basis, register, manage, report, archive the assessments and carry out marketing for BREEAM Schools at a company level. For this, the assessment organization charges a fee to the clients and the design team based on the fee structure recommended by BRE. As part of BRE's responsibilities it has to maintain the quality of the technical content of BREEAM Schools, carry out improvements as and when required, train the assessors, promote BREEAM, certify the school projects, and police the quality of assessments.

The "Information Required Schedule" which details the documents required to be assembled for the assessment meeting is categorized in two sections – general information and detailed information. The general information section seeks information about the project, the client and the design team. The detailed information is required to be collected with respect to each category.

Comparison with LEED: As BREEAM has evolved to be a first-of-its-kind rating system, it has served as a point of reference to all other rating systems, including LEED. LEED has categories similar to BREEAM in its reference guide, but under different names, and the criteria are more related to the U.S. construction industry. While BREEAM has a three-tier system for which the assessment organization is the link between the design team and the certifying body (BRE), in LEED the certifying organization (USGBC) is in direct contact with the design team. The USGBC has the advantage of being aware of the concerns

of the designers due to direct contact, but it also burdens itself with preparing guidelines, updating the quality of its guidelines and reviewing the projects for certification. This can affect the performance of the organization.

The assessing organizations for projects pursuing BREEAM are replaced by Green consultants in LEED. The Green consultants are hired by the designers and are part of the project team. The assessment organization, on the contrary, though hired by the design team, is a third party and not involved in the activities of the project. They only provide guidance and review the project. Both in LEED and BREEAM the clients have to bear an additional cost as the Green consultant and the assessment organization services come with a fee, although BREEAM is relatively less expensive.

TABLE 1 – BREEAM MANUAL GUIDELINES

CATEGORY	ISSUES ADDRESSED	POSSIBLE CREDITS	WEIGHING FACTOR
Management	Management policy, commissioning site management and procedural issues	20	0.15
Health and Well-being	Indoor and external issues that affect the health and well-being of the occupants	19	0.15
Energy-use	Operational energy and carbon dioxide issues	15	0.25
Transport	Transportation, factors related to the location of the site	6	
Water	Water efficiency measures and reduced consumption	7	0.05
Materials	Materials used, their environmental implications and life cycle impacts	17	0.10
Land-use	Greenfield or Brownfield	3	0.15
Ecology	Conserve the ecological value of the site and enhance it further	10	
Pollution	Water and air pollution	12	0.15
Total		109	1.00

GBTool

Introduction to GBTool: GBT05 is the latest version of GBTool which is a software implementation of the ”Green Building Challenge” (GBC) assessment method. The GBC process was initially developed and launched by Natural Resources Canada in 1996, but its responsibility was handed over to the International Initiative for a Sustainable Built Environment (iiSBE) in 2002. Around 15 teams across 12 countries are involved in the development of this software. The primary research and development for the software is carried out by iiSBE and they help the teams in various countries to calibrate the software for the local conditions. The foundation on which GBT05 is based is that a common rating system with similar criteria for environmental assessment cannot be applied to all building types across the world as there are climatic variations across the globe and local issues are of vital importance. Hence, iiSBE only develops generic criteria and methods of assessment, whereas the teams for various countries modify the criteria to suit the local conditions within the base model of GBTool. The GBT05 also takes into consideration the prevailing environmental rating systems such as LEED and Green Globes and gives a comparative assessment of their applicability with respect to these systems. At present, GBT05 is in the process of testing their assessment model on case study buildings in Brazil, Canada, Chile, France, Hong Kong, Israel, Italy, Japan, Korea, Mexico, Poland, Spain, Taiwan, and the U.S.A.

Features of GBT05

- GBTool covers sustainable building issues beyond green building issues and the scope can be broadened or narrowed with respect to the region in which it will be applicable.
- The third parties located in various regions and affiliated to iiSBE can modify or replace the parameters stated in the generic form of GBTool to suit the region and the occupancy type.
- GBTool is available in languages local to the region.

- There are four assessment levels carried out for the project based on the distinct life cycle of the project. The phases are Pre-design, Design, Construction and Operations.
- The software can handle three different building types at a time in a mixed-use project, new and existing construction or a combination of both types.
- Comparisons can be made between GBTool and Green Globes or LEED.

Structure of GBTool: GBTool is designed to be used through Microsoft Excel, which is very commonly available. The GBTool software is made of two parts, namely GBTool-A and GBTool-B. GBTool-A is the parent module of the software whose rights are given to the third-party assessors in the various regions to carry out modifications in the software. These modifications could be, changing the parameters to adjust to the local factors like building regulations, local climate, economic constraints, social character, cultural beliefs, occupancy type, and any other criteria exclusive to the region, replacing completely or deleting the parameters not applicable to the region. GBTool-B is the module dependent on GBTool-A and any changes made to the module-A will directly be updated in module-B. GBTool-B will be the module given out to the design team applying for evaluation under GBC environmental compliance. The data filled out in the GBTool-B excel sheet is evaluated by the regional third party during certification. The relation between iiSBE, Regional Third Party and the applicant design team is shown in ***Figure 2.1.***

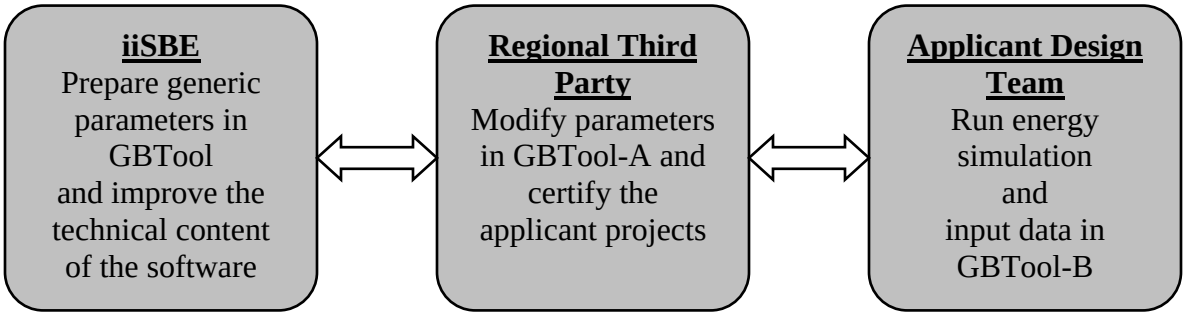

Figure 2.1: Relation Between iiSBE, Regional Third Party and Applicant Design Team in GBTool

GBTool is structured with three levels of parameters. The first set of seven parameters is called the ”Issues” and they are numbered alphabetically from A to G. Each Issue consists of

”Categories” and each category consists of a set of criteria. All criteria have a percentage weight within the GBTool model and not all the criteria may be applicable across the four phases (pre-design, design, construction and operations) of the project. In GBTool-A for each criteria there are four benchmark options. The assessors can override any or all of these with new benchmarks that are suitable to local conditions. There is a score associated with each of these benchmarks. The lowest benchmark usually receives a negative score of -1, the next level is an acceptable practice score of 0, which is usually equivalent to the regional codes, the good practice level gets a score of 3 and the highest score of 5 is given to the best practice benchmark. Refer to ***Figure 2.2***. The benchmarks are of two types – textual and numerical. Some of the criteria may have a mandatory benchmark so that a specified score has to be achieved.

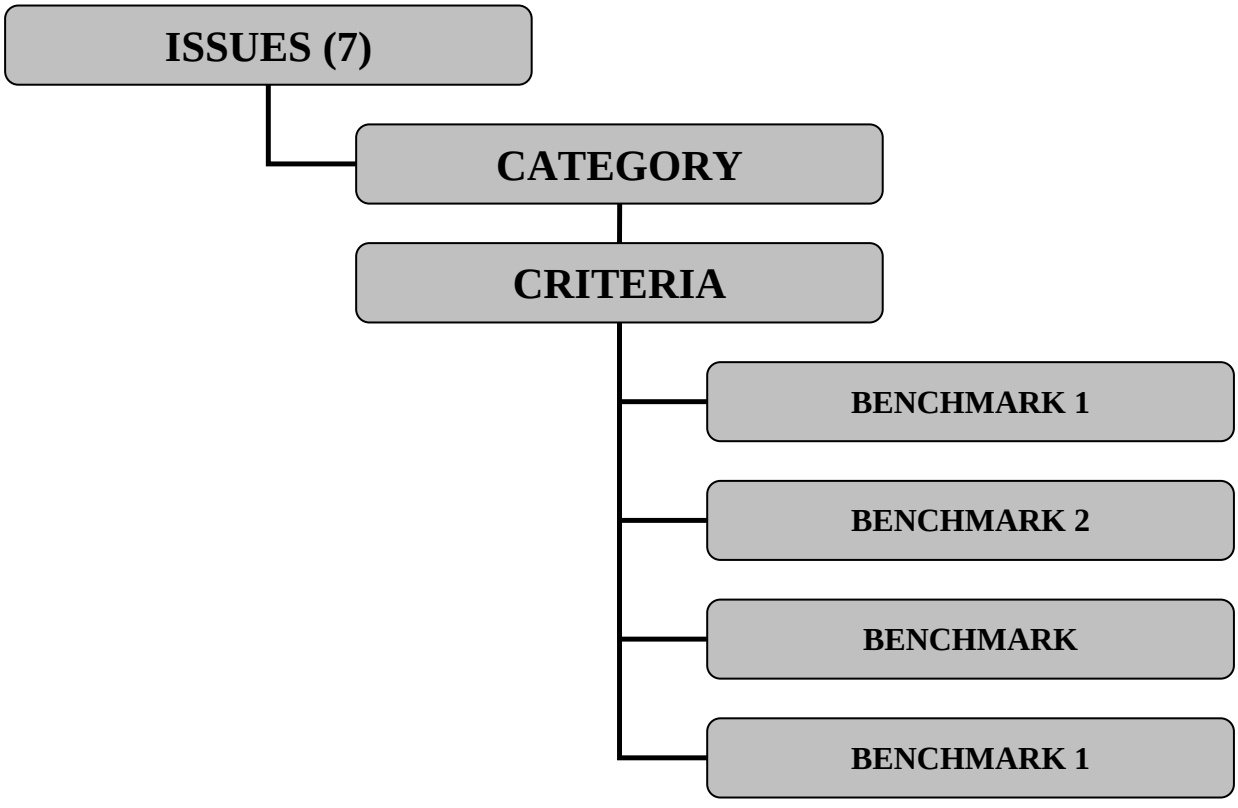

Figure 2.2: GBTool Hierarchy of Parameters

Evaluation for compliance under GBTool can be carried out separately for the four phases of the project life cycle – pre-design, design, construction and operations. The issues,

categories and criteria along with the benchmarks remain the same, but a certain criterion may be deactivated for a phase where it is not applicable. The design team can fill in the data and evaluate the potential sustainable performance of their building at the end of the design process, but it is purely for self-assessment as there are possibilities that changes may occur during the construction phase. The construction phase assessment is carried out by the third party assessor at the end of construction and commissioning phase but before occupancy as it provides a realistic image of the project. The Operations phase is evaluated only after the building has been occupied and functioning for a year as it can illustrate the actual performance of the building. The applicant design team can opt for undergoing evaluation for any or all of the phases.

Once the required data is input in the GBTool-B spreadsheets, the results are generated by the software in the ”Results Spreadsheet.” Each phase will have its individual results represented on individual spread sheets. The table of results includes,

- Number of Criteria applicable to the project
- Score of the building for each issue and the total score for a phase
- Performance scores for – embodied energy, energy for building operations, renewable energy, portable water, rain water, grey water, emissions from the equipments, temperature swing and percent reuse of the building.

Comparison with LEED: LEED is a paper-based rating system. Although its latest version has gone online, it still requires documents to be submitted when the credits are audited for certification. GBTool, on the contrary, was always developed to be an online rating system. The design team has to fill in the data wherever the system prompts them to do so. In GBTool the applicant team has to input the values that they are prompted to fill and the software does all the calculations that are required to assess the building. In LEED all the calculations are supposed to be carried out by the applicant team and included in the submittal for certification. GBTool has the appeal of being less time consuming and more cost effective for documentation. It is also more performance oriented as the certification for environmental performance of the building is assessed only after construction is completed

and once again after the building has been occupied for a year. GBTool does not evaluate the building during its design phase as building performance during this phase can only be predicted and not assessed. The design team can carry out self-evaluation to understand the potential environmental performance of their building.

GBTool is intended to be a global rating system as it shows sensitivity to local parameters. Although LEED is promoted internationally, its environmental guidelines actually concentrate on the conditions applicable to the U.S. GBTool is yet another rating system based on a three-tier system which acts to its advantage as iiSBE can dispense responsibility of a region to a local third party. This reduces the complexity of managing certification for various regions based on the local parameters. For some, the understanding and use of the software may be intimidating, but rather than being complex it is actually fairly straightforward.

Collaborative for High Performance Schools (CHPS) Best Practice Manual

Introduction to CHPS: The turn of century saw a unique trend in California. Statistics showed that the state was educating one out of every eight students in the U.S. with enrollment rates four times higher than the national average. This burst in student population strained the aging infrastructure of school districts. At least 30% of existing facilities required major renovation and more schools were required to be built to accommodate the increased enrollment. Another important factor that raised concern amongst the school districts was the escalating price of energy. Schools are always on tight budgets and collectively school districts were spending nearly $700 million per year on energy. However, despite these problems, the situation was looked upon as an opportunity to improve the learning environment in the state by taking measures to reduce energy use, conserve resources and introduce innovative design.

The California Energy Commission and various power sector companies came together to introduce energy reforms and as part of this effort CHPS was launched in California in 2001. CHPS aims to increase the energy efficiency of schools through marketing information about its resources on testing, emissions, and materials, providing services such as training

programs, giving incentives to the school districts and designers for good environmental practice, and devising tools such as ”CHPS Best Practices Manual.”

CHPS’s goals are as follows::

- Increase performance of the California students by providing better facilities and well-designed spaces.
- Raise the level of awareness amongst the school districts about the advantages of high performance learning environments.
- Provide designers with information and tools to facilitate better design and energy efficient architecture.
- Make the schools in California energy and resource efficient.
- Reduce peak electric loads.

With the aim to achieve these goals, the four Best Practice Manuals (BPMs) of CHPS were developed.

Structure of BPM: Each volume of the Best Practice Manuals provides guidance to a different group of people associated with school design: Volume I – Planning-is a guidebook for the school district planners; Volume II – Design-provides guidance to designers, consultants and contractors; Volume III – Eligibility Criteria-consists of credits to rate the building; and Volume IV – Maintenance and Operation-has guidelines for the maintenance and operation staff.

Volume I – Planning: This volume is an informational manual of Best Practices which describes the various factors involved in planning a school. It is specifically written for members of the school district such as, school superintendents, school business officers, school facility planners, school board members, interested parents, and any other person involved in the planning of a school. The manual discusses the benefits and characteristics of high performance schools and their relation to health and productivity of the occupants. The popular environmental strategies adopted for high performance schools are explained and

there is a brief description on the criteria for evaluation under CHPS. There is information provided about the stages involved in California State Funding and Approval Process for schools. In this manual, CHPS takes the responsibility to encourage and inform the school authorities about high performance learning environments, hence reducing the burden off the design community interested in environmental design.

Volume II – Design: As the name suggests this volume is intended for the architects, engineers and projects managers involved in the design and construction of high performance schools. If volume I introduces the characteristics of high performance schools, then volume II goes a step further in discussing the technical contents of the guidelines for environmental school design and its economic, social, and cultural impact. Since designing a high performance school is different from a conventional school there are certain goals that this manual proposes for the design team to follow. Their goals could be to achieve thermal, visual and acoustic comfort; energy, water and material efficiency; security and safety for the occupants; protection of the ecosystem; good indoor air quality; and using the building as a teaching tool. The design team in discussion with the school authorities can set the goals for their project preferably during the project inception stage. The manual consists of checklists for each of these goals, which are good reference for the design team aiming for a high performance school. To make their effort worthwhile, the manual advises to bring the consultants and contractors on board by introducing the goals to them. Since CHPS concentrates only on schools it has also incorporated guidelines specific to schools, not necessarily focusing on environmental design.

Volume III – Eligibility Criteria: This volume has a menu of all the guidelines and the criteria required to fulfill them, hence the name Eligibility Criteria Manual in Best Practices. All the goals mentioned in volume II are divided into categories such as site planning, water efficiency, energy efficiency, materials, indoor environmental quality, and district. Each category consists of prerequisites and credits. To be eligible for CHPS certification, the school should earn all the prerequisites and at least 28 credits (2 from energy required) out of the 81 credits. The more credits the better the performance of the school, but the CHPS system is based only on a pass/fail basis. For the purpose of documentation, the design team or the building owner has to write a narrative for each credit explaining the approach used to

fulfill the credit criteria. The narratives are compiled into a self-evaluation compliance report and submitted to CHPS. CHPS only carries out spot checks of the document as it is a self-evaluation rating system. But, if the funding agency requires a thorough check for compliance with the credits, the program administrators at CHPS conduct a complete review of the document. A typical scorecard for CHPS evaluated school project is included in ***Appendix G.***

Volume IV – Maintenance and Operation: The design team can construct a high performance school, but the building efficiency goals can be achieved only if the staff is capable and equipped to handle the innovative design features of the building. A lack of trained staff to manage a high performance facility can foil the initial effort. Realizing the importance of day-to-day maintenance and operation of the building, this volume was developed. This manual addresses the management and maintenance staff, custodians and ground-keepers. Like the previous volume it has categories such as, facilities management, equipment procurement, building envelope, electrical systems, and lighting, HVAC and mechanical equipments, plumbing, recycling and waste management, cleaning practices and products, landscaping and snow management and de-icing.

Each category is sub-divided into guidelines. A typical guideline has recommendations for the maintenance staff, informs them about the applicable codes and regulations for that guideline and benefits of following the guidelines. It also tells the M&O staff the cost associated with the maintenance and the cost savings due to proper maintenance. There is information included about procuring replacement for the equipment. In addition, reference manuals are recommended for getting information about maintenance methods. These guidelines are again prescriptive and no evaluation is carried out for compliance.

Comparison to LEED: Both CHPS and LEED have written manuals that include similar categories and guidelines and a rating system based on points. But LEED has different levels of rating depending upon the number of points a building is awarded. CHPS rates buildings as pass or fail irrespective of the number of points it may receive. One of the major differences between CHPS and LEED is the method of evaluation. CHPS proposes self-evaluation and the program administrators evaluate the project only when the funding

organization for the project demands it. CHPS certified buildings generally cannot be accepted at face value for their environmental performance as they lack the validity of third party certification. LEED has a mandatory evaluation carried out by the reviewing committee of the USGBC, if the building requires certification. But preparing the documentation for LEED comes with an added cost which does not exist in CHPS.

CHPS was developed specifically to rate Californian schools, although it is trying to expand to the other states in the U.S., whereas LEED rates buildings irrespective of their type of occupancy. Due to this focused approach, CHPS can concentrate its guidelines on schools only and address all the issues associated with high performance schools. CHPS does not require the energy simulation of the buildings; instead it prescribes solutions for energy efficiency in design. CHPS has reference guides for all the people involved in school projects right from the planning to the maintenance of the building as it is trying to reach out to everyone associated with schools. The proponents of LEED have, at times, had a hard time trying to promote LEED to their clients as LEED has focused its efforts to promote green buildings only on the architects and engineers.

Green Globes

Introduction to Green Globes: The development of Green Globes environmental assessment has been under research for 9 years using BREEAM as the starting point for the system. In 1999, BREEAM Green Leaf, which was introduced in Canada, was a precursor to Green Globes. It can be called a hard copy version of the upcoming completely online Green Globes rating system. In 2000 the online rating system – Green Globes for existing buildings - was introduced in Canada and subsequently in 2002 it was launched in the U.K. and an outline version for Green Globes for new buildings was prepared simultaneously. In 2004 Green Globes was introduced in the U.S. with Green Building Initiative, winning the rights for its distribution in the U.S. Some modifications were made in Green Globes to suit the U.S. scenario with the help of several industry leaders and universities. At present, Green Globes has been recommended by Arkansas and Maryland and some other states as the environmental rating system of choice.

Structure of Green Globes: The environmental categories and guidelines for Green Globes are very similar to other rating systems, but its uniqueness lies in the method of evaluating buildings for its environmental performance. The online program generates a set of 150 questions for the designers to answer. Most of the answers are based on a ”yes,” ”no” or ”n/a” basis and a total of 1000 points are associated with these questions. After the design team has filled out the answers for the questions, the program generates a list of environmental features of the building design and provides advice and reference resources for improvements. The design team can check the building’s environmental performance or seek advice from the program at any stage in the life cycle of the project. The intermediate level recommendations from the program can help the design team make changes early on and improve the environmental performance for the final assessment of the building.

The online Green Globes program can be used for self-assessment of the project, but it is highly recommended to get the online rating of the building evaluated from a third party verifier who is provided by the “Green Building Initiative.” The evaluation for the project is done in two stages – firstly, when all the questions for the project are answered and the construction documents are completed and secondly, when the project is completed and the site is available for inspection. During the first stage of evaluation the verifier reviews the working drawings, building specifications, waste disposal plans, evidence of energy and life cycle modeling, and other supporting materials to ensure that the answers given were based on facts and no false claim was made. If the verifier finds conflict between the answer and the fact, he/she can change the answer by giving the explanation for the change. After the final evaluation, the building receives its certification, which can be used by the design team and the owner to promote their building. The certification for environmental performance is given at four levels – one globe for 35% to 54%, two globes for 55% to 69%, three globes for 70% to 85% and four globes for 86% to 100%.

Features of Green Globes:

- Green Globes is a virtual consultant which is interactive as it provides instant feedback on the environmental aspects of the building along with recommendations for improvements.

- For following Green Globes guidelines the building generally costs between 1-2% more that a conventional building and 8% more for buildings in extreme climates. But this cost is due to following green building practices and not the evaluation itself. For using the program an initial fee of $500 is charged and an additional $4000 is required if the project has to be verified for both the stages. It is particularly advantageous for smaller projects as they are typically on tight budgets and cannot spare money for documentation and consultants.

- Life Cycle Analysis of all the materials and equipment used in the building is of prime importance in Green Globes.

- The answers can be changed during the course of the project if the design is modified for better environmental performance. But the changes can be made only until a year from the day the project is registered. Obtaining an extension is possible.

- Since the verifiers review the project at two different stages its helps the project to move forward.

- Green Globes allows one to compare two projects designed by the same architectural firm. Multiple users associated with the project can access the feedback from the program. Information filled in by the design team remains secure and only the team has access to it.

Comparison with LEED: The guidelines for both Green Globes and LEED are to a large extent similar but the major difference is present in the method of documentation. Green Globes does not require any additional documents to be presented to the verifier, whereas LEED needs extensive paper-based evidence during the credit auditing stage. With Green Globes the program generates recommendations for improvement based on the data filled by the design team. For projects pursuing LEED, the services of a green consultant has to be obtained, which creates additional cost along with the cost of the documentation itself. The complete process of certification under Green Globes is highly cost effective. However, because Green Globes is the latest to enter the environmental efficiency market it could be some time before any problems or issues in Green Globes can be recognized.

Chapter Summary

The literature reviewed in this chapter is a brief study of the four popular environmental rating systems – BREEAM, GBTool, CHPS and Green Globes – prevalent mainly in the U.S. and contemporary to LEED. This chapter traced the history of these rating systems and attempted to understand their structures. Most of these rating systems have similar criteria for evaluating buildings, but there is a significant difference in their method of evaluation which this chapter made an effort to clarify. Each of these rating systems was compared to LEED in terms of its structure and method of assessment.

CHAPTER 3 RESEARCH METHODOLOGY

Introduction

This chapter describes the qualitative research methodology adopted for exploring various issues and problems faced by the designers, engineers and consultants during the LEED documentation process for school projects. The nature of this research suggested a qualitative methodology. The research data came directly from the participants in the form of words, not numbers. Each data set was unique as it captured information from the perspective of different individuals. The participants were the independent variable in this research. Participant selection criteria were exercised so that only people from the building industry involved in school projects and with certain knowledge about LEED were invited to participate in this research. The research investigated multiple realities for a phenomenon as no one person's experience with LEED documentation process was identical to another. Only a qualitative method has the scope for exploring a multi-faceted problem such as this.

Selection of Participants

The participants required for this study were selected from the LEED projects contact information on the USGBC website, people from the building industry known to the research

advisor and list of school architects from online databases. The target population included architects, green consultants, and engineers experienced in school projects who have knowledge concerning LEED. As this target population was geographically scattered and there was no single database enlisting all population units, the actual size of this population is not easy to ascertain. A list of the population sample accessible through available resources was prepared. A sample size of 15 subjects was decided upon and it did not necessarily represent a particular proportion of the target population due to restricted resources. A non-probability sampling method was used to select the target sample of participants as the researcher did not have control over the choice of participants for the research. Purposively, a total of 160 potential participants from various firms were invited for the survey to try to maintain diversity in the targeted sample. The researcher took utmost care to avoid any bias in the selection as it is one of the major drawbacks of purposive non-probability sampling.

In July and August 2005, a letter inviting participation in a survey on the LEED documentation process was drafted and sent out through email to 160 people from different architectural, engineering and consultancy firms. The selection was restricted to the U.S. with a wide diversity in terms of experience with school projects, expertise with LEED, size of the organization represented by the architect or engineer or consultant. The draft of the ”Invitation Letter” can be viewed in ***Appendix C.*** Out of the total invitations sent, 15 of the email addresses were non-functional and the emails bounced back. Only 35 out of the remaining 145 replied. Five invitees expressed their unwillingness to participate, 30 agreed to participate in the survey and the rest did not reply. Another reminder email was sent to encourage the non-responding architects, engineers and consultants, but in vain. This part of the research was coordinated by a team of two research members as the target sample for both was the same.

During September through November 2005, the other member of the research team conducted the survey with the subjects who had agreed to participate. This study was carried out in parallel with the other survey for the convenience of the participants while maintaining a distinction between the two studies. Although the two studies are different, from the participant’s point of view, the results presented in this thesis book are derived from phase II of the survey.

(Phase I studies the appropriateness of existing LEED design guidelines for school projects. The design guidelines are believed to favor high end commercial projects. This phase of the research tries to find the problems faced, by the design team, while applying LEED guidelines to school projects. The research methodology for phase I, to some extent, is similar to the method followed in phase II. But being a qualitative research, differences between the two methods are bound to exist. Although both phases of the research try to remain distinct, they still complement each other. It is recommended to refer to both studies simultaneously.)

During the course of phase I of the survey, 5 participants dropped out. In December 2005, the 25 participants from phase I were sent a letter seeking confirmation for participation in phase II of the survey. The participants had an option to withdraw from the survey even if they had participated in phase I of the survey. Eleven out of the 25 agreed to continue their participation; one of the participants from the 11 was replaced by another member from the architectural firm as the previous participant from their office had quit the firm; 3 informed the researcher of their withdrawal from the survey; 1 participant agreed to participate after the survey was closed; and the remaining did not respond. Out of the confirmed 11, one of the participants withdrew during the data collection stage and without signing the ”Informed Consent Form,” hence that subject was ruled out of the survey, reducing the participant count to 10. During the same month, 7 additional professionals from the building sector were invited to participate and 5 agreed. Hence the sample size of 15 participants was obtained. All the potential participants were repeatedly called to confirm their participation in the survey.

An ”Informed Consent Form,” informing the participants that the survey would be audio recorded was sent to them through an email. The Institutional Review Board at Virginia Tech, which is involved in protecting the rights of the subjects of surveys, requires the participants to sign the informed consent form to confirm that they are aware that their conversation is going to be recorded to be used as data for the research. This form was sent back to the researcher either through email or fax.

Development of the Instrument

The instrument for research was developed with reference to the LEED documentation process for the target sample mentioned in the previous section of this chapter. Two survey questionnaires were designed to be used as instruments of measurement for this research. The first instrument was a ”closed fixed-response questionnaire” as the participants only had to select the response most appropriate to them from the given options. This was a structured questionnaire from which the responses could be measured. All the credits under LEED were listed in this questionnaire and corresponding to each was a numerical scale from negative 3 to positive 3. The negative 3 denoted the highest level of ease in documenting the credit and positive 3 denoted the highest level of difficulty in documenting the credit while 0 represented the neutral response. Only one choice per credit had to be marked by the participant. The closed fixed-response questions are listed in ***Appendix A.*** This questionnaire was sent to the participant along with the ”informed consent form,” and they returned it through fax or email.

This research followed a qualitative method of interviewing as the study sought to explore the difference in the experience and outcomes of the LEED documentation process, to understand the needs of the group of people involved with the documentation, and to obtain suggestions for refining it. The other instrument of measurement was designed with a combination of standardized open-ended questions and interview guide approach. Although a draft of the questionnaire was made, the option to modify the questions during the interview to suit the participant was never ruled out. Even additional questions could be asked if it seemed necessary during the course of the interview. The order of addressing the questions was kept flexible, but with the limit of logical sequence. The ultimate aim of combining the two approaches of interview design was to get the required data from the participants. A draft of the interview questions was sent to the participants two days prior to the interview.

The questionnaire started with an introductory question which made a presupposed statement to encourage the participants to relax and come out of their shell. This was followed by two or three questions within each of the six LEED categories. The questions did not directly ask for comments on any particular credit, but they were generic to the category.

If required, credit-focused questions were also included. The questions were framed to seek suggestions and opinions of the participants. The concluding question asked for their comments on the survey and for information which the participants felt was important but not included in the survey. A draft of 19 questions was prepared and it is included in ***Appendix A.***

The interview questions were exploratory as they were seeking answers for the research questions. Each interview question was targeted at one research question. Interview questions 1, 2, 5, 7, 10, 12, and 13 address research question 1 to provide information about the difficulties faced by the participants while documenting credits under LEED. Interview questions 3, 4, 6, 8, 9, 11, 14, 15, 16, and 17 address research question 2 in giving suggestions to improve or modify the documentation process. Finally, research question 3 is addressed by interview question numbers 18 and 19, for which participants proposed newer methods of evaluation which can be innovative and borrowed from other rating systems. The research questions are included in ***Chapter 4.***

Pilot Test of the Instrument

One of the participants in the survey agreed to undergo an interview prior to conducting interviews with the other participants. Initially the participant wasn't informed that it was going to be a pilot test because the interviewer wanted to test the instrument in a scenario similar to the forthcoming interview. Only at the end of the interview was the participant asked to comment about the contents of the instrument, the duration of the interview, the efficacy of the interviewer and any other relevant topics. The interview was conducted through audio conferencing on telephone. The summary of the pilot test is as follows:

- The questionnaire was not difficult to understand.
- The participant did not find the words unfamiliar or difficult to understand.
- All questions were relevant and no additional question was required.
- The interview lasted for approximately 40 minutes.

- The researcher had to slow down the pace of speech to let the participant grasp the essence of the question.

- Emphasis had to be laid on the word ”documentation” as the participant assumed that the interview was with reference to difficulties in achieving LEED guidelines instead of documenting them.

The participant confirmed that no changes were required in the interview questions and hence the same instrument was used for collecting data from the remaining participants.

Data Collection Methods

The first source of information for the research was the responses marked by the participants on the closed fixed-response questions. The questions were sent through an email to the participants on which they marked their choice of answer and sent back the completed sheet through email or fax. The response of the participants to the interview questions was the second source of data for this research. The final source of data was the profile requirements of the participants. All the information that was essential for the research was obtained from the participants.

The confirmed participants were provided a timeline through an email and were asked to select the most suitable day and time during the second half of January 2006. Due to overlapping choice of days and slow response from the participants, several telephone calls were made to get an appointment suitable to the interviewee and the interviewer. A draft of the interview questions was sent to the participants two days prior to the interview. Due to the scattered location of the participants, all except two interviews were conducted through telephonic audio conferencing. Two participants agreed to undergo the interview at the College of Architecture and Urban Studies (CAUS), Virginia Tech conference facility. Thirteen participants undertook ”telephonic interviews” and two accepted ”face-to-face interviews.”

Telephonic Interview: The equipment used for conducting these interviews is not traditionally used for recorded interviews. Hence, this equipment had to be tested before use. The audio conferencing telephone in use had an audio-out slot which could be connected to

the audio-in (speaker) slot on a computer (laptop) through an audio transfer cord. The MP3 Audio Recorder software was installed on the laptop. After the connections between the conference telephone and the laptop were set up, any conversation through the conference calling machine could be recorded on the laptop as an *.mp3 or *.wav file with the aid of the software. The whole set-up was trial run successfully in the dean's conference room in the CAUS. All the interviews were conducted at the same facility.

Prior to the interview, the interviewer studied the responses to the closed fixed-response questions to decide which interview questions would be applicable to the interviewee. Any questions related to the categories in LEED which were not documented by the interviewee were not asked during the interview. This was done to optimize the data coming from the source and reduce the duration of the interview to an appropriate length. The equipment was set-up before the interview and the participants were informed before the recording of the conversation and after it was stopped. Most of the interviews lasted approximately thirty minutes with the exception of a few which were in the forty-five minute range.

Face-to-face Interviews: These interviews were conducted similarly to the telephonic interviews except for the change in the equipment. Instead of the conference calling machine, a microphone was connected to the laptop audio-in (speaker) slot and the same software was used for recording the conversation at the same facility.

A follow-up email was sent to the participants with their profile requirements in a fill-in-the-blank format and their contribution towards the research was also acknowledged.

Data Analysis Method

Interviews, which were the source of data, were analyzed to arrive at the conclusions and give recommendations. The data obtained was unstructured and measured the issues and responses from the participants. To extract the essence from the quantum of data, systematic condensation of the data was carried out. Each interview was first transcribed and then classified in three categories which were in context to one of the three research questions (*refer* ***CHAPTER 4***). The categorized transcripts were then summarized. Summaries are relevant and precise information which facilitates coding. The codes from all the summaries

were clustered together for each research question and tabulated in a comparative pattern. Strategies, conditions and key issues started to emerge from the comparative table. These issues which transpired were categorized into key, unique, and additional issues. Since the research is qualitative in nature, even the unique issue can be relevant and hence was not ignored. The recommendations given by the participants were also classified into suggestions for USGBC and for the design teams. A summary of the findings for barriers, recommendations, and alternatives to the LEED documentation process which emerged from the themes were listed in columns and rows. Conclusions were drawn from the findings and participant recommendations.

Ethics in Research

Human subjects are the source of data for this research. Scheduled interview conversations with the participants were recorded according to ethical guidelines. The guidelines followed for this research are listed below.

- The invitations sent out to the prospective participants clearly stated the purpose and nature of the study and the extent of obligations involved in the study. Refer to ***Appendix B.*** Participation was voluntary and the subjects had the freedom to withdraw from the research.

- Participants were not exposed to any risk, so the gains from this study clearly overweigh any potential risks.

- The identities of the participants shall always be protected in all written or electronically published work.

- The researcher has full respect for the participants and this study shall not humiliate or cause any harm to the participants. The participants were informed about the interviews being audio recording and their consent was obtained on the ”Informed consent form.”

- The findings from the collected data are truthfully reported.

Since the conversations involving human subjects were recorded for data collection, an approval for the study was obtained from the Institutional Review Board (IRB) of Virginia Polytechnic Institute and State University. The collection of data was approved for September 01, 2005, to September 01, 2006. The application package submitted to the IRB included a protocol for the research, an informed consent form, the letter of invitation sent out to the participants, a list of confirmed participants, a list of potential participants, and the questionnaire. ***Appendix C*** includes the IRB application package documents.

Chapter Summary

This chapter described the method of applying qualitative design to this research which included deciding on the population; resources used for locating the sample; selecting the target sample; and, the process of selecting a final target sample for research. The chapter also explained the design of the instrument for survey, the method of collecting data from the sample group, and additional information required for the research. A description of the method adopted for analyzing the data and the ethics followed, while collecting the data was also presented in this chapter. Both these stages of research are elaborately discussed in the following chapters.

CHAPTER 4 DATA ANALYSIS AND FINDINGS

Introduction

This chapter analyses the data collected from the survey to answer the three research questions. The research questions which explore the answers to the objectives of this study are as follows:

Research Question 1: What are the barriers posed by the current LEED documentation procedures to the overall design and construction process of a school project?

Research Question 2: How can the evaluation technique be modified to be suitable for school projects?

Research Question 3: What newer methods of evaluation can be introduced or borrowed for environmentally sensitive schools?

A synopsis of respondents' responses to the research questions are presented and then coded to obtain a summary of responses. The patterns emerging from the summary of research question 1 presents the barriers the participants faced while documenting their LEED project. These answers are categorized as the findings for this research. The themes

emerging from research questions 2 and 3 are categorized as participant recommendations. The findings and participant recommendations along with the research interpretation will be summarized in the concluding chapter.

The profile of the participating firms presents the representation diversity of this survey.

Profile of Participating firms

Fifteen participants were interviewed for this research; eleven were architects by profession, one was an engineer and two were Green consultants. It is a diverse group within the required criteria. ***Although the participants were individuals participating in their own right, in this survey they represented the firm at which they were employed or are the employer.*** Two such offices had two participants each involved in the survey; hence, their profiles are combined in the table. The profile of the firms represented by the participants for the research is presented in ***Table 2.*** The description of the profile was obtained from the participants themselves. The profile lists their professional qualifications, the states in which their projects are typically located, their firm's years of experience in school projects, the total number of school projects their office has undertaken, the number of LEED registered school projects to date, the number of LEED certified school projects to date, the average size of the projects (preferably in terms of square footage), and the number of employees (to determine the size of firm).

The profile of the participating firms was used to understand the extent of diversity represented by the participants and their firms. During the process of sample selection, attempts were made to select architects, engineers and consultants as a cross section of LEED expertise. The data from the profile was used to prepare some comparative tables of participant representation.

Table 3 shows the variation in firms with differing years of experience in handling school projects. Firms with 5 or fewer years and 26 or more years experience in school projects comprise 31% participation each; firms with 5 to 15 years of experience have a 23% representation in the survey; and firms with 16 to 25 years experience have 15% participant representation. The ideally balanced representation would be 25% for each category. In this

table it is observed that the two extreme categories of firms have 6% more participation than the mean percentage. The firms with 5 to 15 years experience are closer to the mean and the 16 to 25 years experienced firms fall short by 10% in their representation. If a comparison is made between categories 1 and 2 (54%) with categories 3 and 4 (46%) the balance shifts towards the lesser experienced firms and as the number of firms with more than 15 years experience are lesser in number, this representation of firms is acceptable.

In ***Table 4***, the size of the participating firms is shown. Firms with 10 or fewer employees and 25 to 49 employees have 23% representation each; firms with 11 to 24 employees contribute to 15% participation; firms with 50 to 100 employees have 31% representation; and firms with more than 100 employees have 8% representation. Categories 1, 2 and 3 are smaller firms; category 4 is a medium-sized firm; and category 5 is large-sized firm. During the course of the survey it was observed that larger firms hire external LEED consultants to carry out the documentation and at times were unable to contribute effectively to the survey. On the contrary, the small and medium-sized firms, due to budget constraints, had to undertake additional responsibility of handling the LEED documentation and were completely involved in it, which was advantageous for the research while obtaining data from them.

LEED is a relatively new rating system (launched in 1998). The building industry is getting accustomed to obtaining LEED certification for their projects; therefore, the expertise of the people involved with LEED is mostly restricted to one or two projects. This fact will also be observed in the participant representation in ***Table 5*** which shows the balance tilted towards the participating firms with lesser LEED experience. Among the participants, 39% had one LEED project experience, which included both in-process and completed projects. Twenty-three percent of the participating firms had 2 to 3 projects experience; and another 23% had 4 to 9 projects experience. Only 8% participants (1 participant) had experience documenting more than 10 LEED projects, whereas the same percent participants had knowledge of LEED but never had the opportunity to actually document the project for LEED.

Most participants' projects are concentrated in certain states of the U.S. Each state belongs to one of the nine major climatic zones for U.S. A regional diversity in representation was required because each region has its unique character and the opinions obtained from the participants reflect their experience with respect to the region. This gives the survey results a wider scope of applicability. All the states where the participants had their LEED projects were grouped according to regions and the regional representation was obtained. It can be observed in ***Table 6*** that although each region has at least one participant representation, there are more participants from the eastern zones. The 8% representation for the east north central region, 23% for the northeast region, and 33% for the southeast region is possibly due to the proximity of the participants to the location of the researcher.

TABLE 2 – PROFILE OF PARTICIPATING FIRMS

PARTICIPANT	PROFESSIONAL QUALIFICATION	PROJECT LOCATION	EXPERIENCE	TOTAL PROJECTS	LEED REGISTERED	LEED CERTIFIED	AVG. SIZE OF PROJECTS	SIZE OF FIRM
			Yrs.	**/Yr**	**Till date**	**Till date**	**sq. ft.**	**employee**
A	Consultants	NC SC MI KY	29	7.5	4	0	180,000	13
B	Architects	MI	5	0.4	0	1	175,000	85
C	Engineers	VA NC	12	20	10	1(gold)	$35,000,000	320
D	Architects	NJ PA	10	3	5	0	80,000	50 (education)
E	Architects	NV MO KY NY	11	8	1	0	80,000	9700 (global) 68(St. Louis)
F	Architects	IL	60	2	0	1	120,000	100
G&H	Architects	PA	25	20	1	1 (In process)	$8,000,000	25
J	Architects	VA	40	7	0	0	$8,000,000	30
K	Architects	ME	18	3	1	1 (In process)	70,000	15
L	Architects	TX	3	3	1	0	60,000	4
M&N	Architects	VA	3	1	1	1 (In process)	10,800	3
P	Consultants	WA DC midwest southwest	29	42	4	2	-	30
R	Architects	VA	3	2	1	0	20,000	4

NOTE:

1. All details mentioned in the above table are with respect to school projects.
2. The highlighted figures denote that the information is given by the participant in terms dollar size of the project and not square footage.

TABLE 3 – FIRM EXPERIENCE IN SCHOOL PROJECTS

CATEGORY	YEARS OF EXPERIENCE (SCHOOL PROJECTS)	NUMBER OF PARTICIPATING FIRMS	PERCENT REPRESENTATION OF FIRMS
1	5 and Less	4	31%
2	6 to 15	3	23%
3	16 to 25	2	15%
4	26 and More	4	31%

NOTE:
1. Categories 1 and 2 together = 54%
2. Categories 3 and 4 together = 46%

TABLE 4 – SIZE OF FIRM

CATEGORY	NUMBER OF EMPLOYEES	NUMBER OF PARTICIPATING FIRMS	PERCENT REPRESENTATION OF FIRMS
1	10 and Less	3	23%
2	11 to 24	2	15%
3	25 to 49	3	23%
4	50 to 100	4	31%
5	More than 100	1	8%

NOTE:
1. Categories 1, 2 and 3 = Small size firms
2. Category 4 = Medium size firm
3. Category 5 = Large size firm

TABLE 5 – LEED EXPERIENCE

EXPERIENCE IN LEED PROJECTS	NUMBER OF PARTICIPATING FIRMS	PERCENT REPRESENTATION OF FIRMS
None	1	8%
1	5	39%
2 to 3	3	23%
4 to 9	3	23%
10 and more	1	8%

TABLE 6 – REGIONAL REPRESENTATION

REGIONS	REGIONAL REPRESENTATION	PERCENT REPRESENTATION OF REGIONS
West	1	4%
Northwest	1	4%
West North Central	1	4%
East North Central	2	8%
Northeast	5	23%
Southeast	8	33%
South	1	4%
Southwest	2	8%
Central	3	12%

Research Questions Responses

Research Question 1: What are the barriers posed by the current LEED documentation procedures to the overall design and construction process of a school project? (Interview Questions 1, 2, 5, 7, 10, 12 & 13)

Participant A: Since participant A is a green consultant the opinions also commented on the architect's approach towards LEED. The main problem the participant thinks is the lack of expertise in architects to pursue LEED and they have an unskilled support team in the engineers and contractors. Documentation is not the most difficult part of LEED; it is easy if the categories and credits are structured appropriately. Two-thirds of the global atmospheric issues are related to energy and it gets a meager 10 points in LEED. The onsite renewable energy credit is product driven as it does not include the use of a majority of solar applications besides photovoltaic. LEED does not account for synergies and no incentives are given for going beyond the requirements. Some of the requirements, like 50% water from a rainwater system, promote mediocrity in design as in practice it is possible to go beyond the LEED requirements. For school projects budget is a major issue and sparing money for commissioning is generally considered irrelevant. A third party commissioning means that the architects and engineers in the project cannot be trusted to do a good job, whereas for energy performance of the building only the calculations are trusted without actually evaluating the building onsite. This shows inconsistency in the method of evaluation. For materials procurement and documentation, it is difficult to get accurate information as the manufacturers do not always provide the right details and the contractors do not include the cost of green products upfront in their bids as it increases the quotation amount. The present structure of LEED has many requirements which are not suitable for schools.

Participant B: The clients are not aware of the benefits of LEED and the cost for certification and documentation along with additional fees for architectural, engineering, and commissioning services increases their reservations about LEED. Another reason the clients are reluctant is the lack of education of the maintenance staff about the upkeep of green materials. The reluctance and lack of knowledge of the contractors causes delays during construction and while getting the documents submitted. They do not have the understanding

of the required information about materials for the documents and there is a to-and-fro process as the information they get initially is wrong. The manufacturers also do not have the details about the materials readily available as they have various sources for collecting the materials. The contractors charge more or over bid for collecting additional information for LEED documentation. So, documenting, especially for materials and resources category is a time consuming and cumbersome process. A design phase delay was caused as the design team was inexperienced and had difficulty in finding the right materials for the project. The documentation for brownfield sites in the sustainable sites category is time consuming as it requires reading a lot of technical data. The documentation for other sustainable site credit has been simplified in version 2.2. The water efficiency category were easy to document, but some credits, according to the plumbing consultant, are time consuming. The energy modeling for the energy and atmosphere category requires additional work from the mechanical engineers, it is time consuming, the TRANE software is cumbersome and there is a constant to-and-fro between the mechanical and design teams to incorporate changes. Documenting commissioning was easy as the commissioning agent was experienced and the architectural team did not have to carry out any documentation. In the materials and resources category, it is difficult to trace the waste chain. The daylighting credit is time consuming and has many calculations. For the next LEED projects the participant will not opt for this credit.

Participant C: The main reason clients do not pursue LEED is the additional cost in construction due to commissioning and use of green materials, to name a few. Clients do not have a problem with the LEED certification and documentation costs. Another major problem with respect to documentation is the inconsistency in the review process. The reviewers sometimes demand beyond the credit requirement, which may not be possible to submit. A credit like brownfield is time consuming and expensive to document. But the other sustainable sites credits are simple. For the landscaping credit in the water efficiency category, the level of difficulty in documentation is related to the type of system used. For example, the ”drought tower plantings” is easy to document, but ”cistern storage for irrigation” is complex to prove and, hence, time consuming. The waste water management is again easy to document, but in states like Virginia it contradicts state laws. The state does not allow on-site waste water management if a public sewer is present in the area. The innovative

credits are difficult to document because they require writing a persuasive essay which is not the type of report the technical personnel are used to writing.

Participant D: Several credits were lost during documentation due to lack of contractor knowledge. Credits across the categories in LEED are dependent on the expertise of the contractors. The site can get disturbed, incorrect materials can land on site, and waste management plans can be disrupted as the contractors are actively involved. Another problem is the tight budget of school districts which cannot bear the additional cost involved in LEED. In the sustainable sites category the brownfield credit has ambiguous requirements for documentation as not all brownfield sites are on the FEMA register. Most of the water efficiency category credits are easy to document except the waste water technologies. If a relatively unknown system is used it consumes time to prepare documents that can convince the LEED reviewers. At times these systems do not comply to the local codes and not many officials are willing to approve it. The energy modeling studies in the energy and atmosphere category are time consuming, expensive, and require expert skills. Not enough expertise is available to design complex energy models with accuracy. There is a constant to-and-fro between the design and mechanical team, which makes this process time consuming and results have to be compromised due to client pressure. Commissioning documentation is affected by lack of awareness on the client's part and additional cost. The category of material and resources is easy to document as there has been years of study done by the office in building a green materials library. Only in case of local materials the dependence for information on contractors is a matter of concern. The daylighting credit is time consuming due to the calculations and highly undervalued for all the effort required. LEED has no additional points for interrelated credits – daylighting causes energy savings, but without any energy credits.

Participant E: Public schools are under the control of school districts and these school districts are mostly conservative about getting involved in new ideas, especially if it is going to lead to extra cost. The money for public schools comes from the tax payers and public institutions and the school districts are responsible for its efficient use. They have construction and maintenance budgets allotted separately. The functioning of the accounting system in school districts is such that, even if excess cost in construction is incurred with a

future goal to reduce the maintenance cost, a cross over of the budget is not possible. Public school clients are cautious and unwilling to adopt LEED. Most public school clients do not just include the physical building, but the development of infrastructure is also included in the project which is atypical for other projects. Since LEED considers the entire geographical site of the project for documenting the category of sustainable sites it is a big task and very time consuming. Documentation for commissioning requires a lot of work. Material procurement in public school projects is through open bids and the choice has to be made from the materials brought by the contractors. Most of the contractors try to get the cheapest materials with recycled content at the least required level. The design team cannot dictate on acquiring a material as it is an open bid process. Contractors lack knowledge about collecting the information for documentation and demanding it from them upfront may discourage the contractors from bidding for the project. As for the other categories of LEED, the required amount of documentation adds validity to the credits.

Participant F: The documentation for a LEED project is cumbersome as architectural firms are not used to the kind of paperwork required under LEED. Clients like the introduction of environmental features for their building, but the LEED certification process does not appeal to them. The lack of knowledge of the contractors is another major barrier in the LEED documentation process. The site selected for the project had a wetland issue and collecting the documents is time consuming for the civil engineer but not difficult. The method of documenting the credit of water reduction under the category of water efficiency is very theoretical and the factors involved in the calculations spreadsheet are not achievable for large buildings. The system of condensation recovery from a cooling tower could not be factored in water efficiency even after saving 350,000 gallons/year because it does not figure out as the actual water used in the system. Proving this credit made documentation a cumbersome process. The energy consultants took a lot of time to model the building for its energy performance and then document the results. It being a large building only increased the time required. The accuracy of the software to predict energy performance is questionable because important factors, such as occupant control, are not incorporated in the software. Commissioning is elaborate and time consuming. But it is good to have commissioning as it can point out the errors in the systems. Previously, manufacturers lacked the required information about materials, but now many of them are proactive in providing the details.

Most of the materials used had recycled content, but not all the materials were documented due to elaborate information. Contractors do not know the importance of the IAQ management plan. The site was photographed on a regular basis for documenting the credit, which was time consuming but not difficult. Documenting the daylighting credit is very complex.

Participant G & H: LEED projects do not go for certification due to the cost involved at various stages of the project. Private schools have to get funding from local foundations or the private market which may not always be willing to support additional expenses. When several buildings are involved in a project, LEED does not demarcate the site boundary for the building under consideration for LEED. It is difficult to decide the extent to which a site should be documented. The category of energy and atmosphere was documented by an engineering firm experienced in LEED projects. Manufacturers are catching up with the technical information required for materials used in the project. But the contractors still lack knowledge with respect to collecting the information from the manufacturers and maintaining the records on waste management plans. The experience of the green consultants helped in guiding the contractors. At present there is no clue to the method of documenting daylighting, although it can be achieved due to the building orientation.

Participant J: The cost of documentation and the time required for it are the two major concerns in the process of documentation for LEED. For the sustainable sites category the documents submitted for the audit are elaborate and collecting these documents from various sources makes it a tedious process. The verification performed can potentially cause the loss of credits which does not go well with the client who has made investments for a LEED certified project. Some of the LEED proposals are in conflict with the building codes. One such example is the proposal of waterless urinals in the water efficiency category which is not approved by building codes. Public school clients get the money for the project from the city council who is the custodian of the public money. As the city council is not involved in the planning of the project any additional cost, such as commissioning, is superfluous to them. According to the mechanical consultants, energy modeling required for LEED is time consuming and expensive. For State projects a procurement process of inviting bids from multiple suppliers does not provide bids which are comparable as green materials are not

readily available due to the low demand. Obtaining the materials through proprietary specification is the option usually adopted, which adds to the cost of the project due to lack of choice. Since contractors have to obtain documents from the manufacturers and separate and record the reused and recycled materials in a demolition project, which involves much work, they are resistant to LEED. In a LEED project, one person should be completely devoted to preparing the submittal and coordinating with the consultants and contractors to obtain the documents. LEED projects would require an additional budget in the range of 8 to 10%.

Participant K: Budget constraints and the time required to collect the elaborate paperwork for documentation are the chief barriers to LEED. The public school authorities, who are the owners of the project, are initially willing because they like the idea, but eventually back out as cost is the deterrent. Eventually, they do not find it justifiable to spend money on LEED certification instead they prefer to spend it on getting some additional facilities for the school. Most of the contractors have no knowledge of LEED and it is a difficult task to get the work done as LEED requires. Getting information for the category of sustainable sites is time consuming although the required expertise for civil work and landscape designing was available. The technologies used also cost additional money. The calculations to prove water efficiency are not difficult, but again are time consuming because of the quantity of fixtures involved in the project. An additional cost is associated with modeling the project for energy efficiency as it requires specialized service not easily available. At present, the problems concerned with commissioning have not come to light as it is still under process. Finding materials for the project was time consuming as this was the first LEED project for the firm. But getting information from the manufacturers was also a big task as they do not have the technical details about the materials readily available. For the indoor air quality category, the concerned contractors had no knowledge about the things that go into LEED. Lots of documents were collected for the credits in this category, but it is too much information about the systems and products and the relevant data had to be separated for LEED submittal. Documenting the IAQ management plan is also time consuming. The method of documentation prescribed by LEED for daylighting is extremely difficult and time consuming. Another major problem in LEED documentation is the review process, for which the reviewers demand additional documents beyond LEED requirements.

Participant L: The main problem with LEED is the additional cost for professional services like LEED consultancy. The school committee, the client for the school project, decides the budget for the project. But this money is granted by the school board and, the committee is answerable to the board for unusually high budgetary requirements. The school boards cannot accept LEED because there are no example projects for LEED schools and they do not wish to be pioneers. So it is the approach which needs to change and not LEED. The building codes were in contradiction with LEED as they did not allow the use of waterless urinals for water efficiency. The calculations are relatively simple. The commissioning process, though appreciated by the clients, could not be fulfilled due to the expense involved in its service. During material procurement the manufacturers cannot provide the information upfront as they are not accoustomed to this record keeping. The contractors also lack understanding of LEED and it is difficult to introduce them to a new approach towards material procurement. Most of these materials are relatively new and have no established credibility in the market. Daylighting simulation is expensive and converting the data of the simulation into a report for submittal is time consuming. One of the major problems with LEED is the equal distribution of points for credits when the actual impact of each credit is not equal.

Participant M & N: The documentation for LEED is involved. It needs coordination between the design team and the civil and mechanical engineering firms. This being the first LEED project for the firm, the lack of experience was a cause for some of the problems. As a designbuild project, there were no clients and the design team had full authority over pursuing LEED. The contractors are also part of the firm and were well aware of the LEED requirements. Although there were budget constraints, it did not stop the team from pursuing LEED. The documentation for the sustainable sites category was not difficult as the civil engineers were efficient and experienced and they looked at LEED as a marketing strategy for their firm. As a designbuild firm the site selection was at the discretion of the design team. The more flexibility LEED gives for providing the documents, the tougher it is to collect the data. This is especially true for the consultants who do not like reading a lot of background work for document preparation. For water efficiency category documentation requirements were not straightforward so the design team had to consult with experienced professionals to understand the requirements. For water reduction and irrigation there is no

base value mentioned from which the reduction has to be achieved as there are no available standards. Due to budget constraints, additional commissioning could not be pursued. Most of the documentation for the energy and atmosphere category was completed by the mechanical engineers who are experienced with LEED requirements. In the materials and resources category the inexperience of the design team resulted in utilizing excess time in the material survey. The sub-contractors did lack information about LEED. Also, documenting the daylighting credit was easier to achieve due to the appropriate site selection. Daylighting is a credit dependent on site selection.

Participant P: There are two major barriers to LEED – one is the cost of commissioning which comes as a surprise to the clients and second are the bids quoted in excess amount by the contractors when informed that the project is registered for LEED certification. The over rated bids discourage the clients from going for actual certification. Some of the credits must not exist for schools. For example, the requirement of a shower area for bicycle riders is redundant for schools as children don't take a shower after cycling to school. The light pollution credit in sustainable sites is hard to document irrespective of the building type. The nature of the credit makes the documentation difficult. The water efficiency category is the easiest to implement and document because we have devised our own internal tools for calculations. As Green consultants, our core expertise is to carry out building analysis and calculations. Again, for the energy and atmosphere category, our professional expertise makes the documentation easy, which may not be true for others. But the problem does lay with the reviewers. The reviewers come from all parts of the country and their interpretation of the local building codes is different from that of the design team. In addition to that, their expectation of providing all the calculations for energy modeling is not possible as it is part of a complex simulation which cannot be documented. This makes the audit process unpredictable. For commissioning, the documentation is easy if you have experienced commissioning agents as they document that credit, but expertise comes with additional cost. Finding recycled or low VOC content of the materials from the manufacturers was difficult initially, but they have become proactive and now keep the information on record. Maybe 30% of the manufacturers are still unaware of the contents of their materials. For the indoor air quality category, unless one is using the displacement ventilation system in a building, the ventilation credit is difficult to document due to complex calculations for proving energy

savings. For daylighting, the LEED excel sheet for detailed calculations is a step towards making the documentation easier; its still a time consuming task to document the credit. The documentation for IAQ management plan has to be provided by the architectural engineering team and the contractors if the contractors are unaware of the requirements and this makes it difficult.

Participant R: Pursuing LEED is a financial decision. Clients, though interested, do not want to strain their budget. While documenting LEED the experience of the design team matters and raises difficulties because mostly everyone is doing it for the first time. Although the documentation for the project has not been completed, it does not look like a challenge. The plumbing and the mechanical consultants are experienced professionals and they have not raised any questions about the documentation. The energy modeling credit is time consuming and requires a lot of back-and-fro between the design and the mechanical team while designing and documenting. Documenting commissioning credit is an elaborate process. Getting information from manufacturers about materials was difficult because they themselves are not aware of the material contents. The building reuse credit was elaborate and time consuming as it required documenting measurements of the various building components and performing calculations. For the credits in the indoor air quality category most of the documentation shall be done at the end which will be a challenge as it means revisiting all the credits. For daylighting the problem is with respect to designing within the existing building which is a limitation for achieving the credit.

TABLE 7 – CODING RESPONSES FOR RESEARCH QUESTION 1

PARTICIPANT	GENERAL (1)	SUSTAINABLE SITES (2)	WATER EFFICIENCY (5)	ENERGY AND ATMOSPHERE (7)	MATERIALS AND RESOURCES (10, 12)	INDOOR ENVIRONMENTAL QUALITY (13)	INNOVATION AND DESIGN PROCESS
A	Design team lacks experience		Promotes mediocrity	Product driven	Manufacturers lack information		
	Contractors lack knowledge			Commissioning is expensive	Contractors lack knowledge		
	Structure of LEED ▪ Lacks synergies ▪ No incentives			Inconsistency in review			
B	Clients unwilling ▪ Budget constraints ▪ Unskilled Maintenance staff	Brownfield is time consuming	Time consuming	Energy modeling is time consuming	Time consuming and Cumbersome ▪ Contractors lack knowledge ▪ Contractors charge more ▪ Manufacturer lacks information ▪ Inexperience of design team	Daylighting is time consuming ▪ Calculations	
				Software is cumbersome	Waste chain untraceable		
C	Clients unwilling Budget constraints	Brownfield is time consuming	Time consuming Product driven	Commissioning is expensive	Cost of Materials		Cumbersome essay writing

PARTICIPANT	GENERAL (1)	SUSTAINABLE SITES (2)	WATER EFFICIENCY (5)	ENERGY AND ATMOSPHERE (7)	MATERIALS AND RESOURCES (10, 12)	INDOOR ENVIRONMENTAL QUALITY (13)	INNOVATION AND DESIGN PROCESS
	Inconsistency in review	Brownfield is expensive	Waste water management Contradicts State Codes				
D	Contractors lack knowledge	Brownfield has ambiguous requirement	Waste water technologies are time consuming	Lack of expertise for energy modeling	Contractors lack knowledge	Daylighting is time consuming	
			Product driven	▪ Time consuming ▪ Expensive		Calculations	
	Budget constraints		Conflict with local codes	Commissioning is expensive			
	Structure of LEED			Clients unaware about Commissioning			
	Inter-dependent credits						
E	Budget constraints	Time consuming		Commissioning is elaborate	Bid process restricts efficiency of LEED		
		No demarcation of site boundary					
	Clients unwilling				Contractors lack knowledge		
F	Cumbersome	Time consuming	Cumbersome	Commissioning is time consuming	Cumbersome	IAQ management plan is time consuming	
	Design team lacks experience	Special site	Product driven	Elaborate	▪ Include each recycled content ▪ $ value for recycled content		
	Clients unwilling		Calculation not practical for large buildings	Energy modeling is time consuming		Contractors lack knowledge	

PARTICIPANT	GENERAL (1)	SUSTAINABLE SITES (2)	WATER EFFICIENCY (5)	ENERGY AND ATMOSPHERE (7)	MATERIALS AND RESOURCES (10, 12)	INDOOR ENVIRONMENTAL QUALITY (13)	INNOVATION AND DESIGN PROCESS
	Contractors lack knowledge			Software accuracy questionable		Daylighting is complex	
G & H	Clients unwilling	No demarcation of site boundary			Contractors – lack knowledge		
	Budget constraints						
		Conflict with local aesthetics					
J	Budget constraints	Cumbersome	Conflict with codes	Commissioning is expensive	Lack of materials		
	Time consuming	Elaborate		Energy modeling is expensive	Contractors lack knowledge		
				Time consuming	Hesitant		
	Structure of LEED						
	Verification at end						
K	Time consuming	Budget constraints	Time consuming	Energy modeling is expensive	Time consuming	Contractors lack knowledge	
	Elaborate paperwork		Calculations	Expertise	Design team lacks experience		
	Clients unwilling	Time consuming			Manufacturers lack information	Elaborate	
	Budget constraints						
	Contractors lack knowledge					IAQ plan is time consuming	
	Inconsistency in reviews					Daylighting is time consuming	
L	Clients unwilling		Conflict with local codes	Commissioning is expensive	Manufacturers lack information	Daylighting	

PARTICIPANT	GENERAL (1)	SUSTAINABLE SITES (2)	WATER EFFICIENCY (5)	ENERGY AND ATMOSPHERE (7)	MATERIALS AND RESOURCES (10, 12)	INDOOR ENVIRONMENTAL QUALITY (13)	INNOVATION AND DESIGN PROCESS
	Budget constraints					Time consuming Expensive	
	Structure of LEED				Contractors lack knowledge		
					Material Credibility		
M & N	Structure of LEED		Vague requirements	Commissioning is expensive	Time consuming		
	Interdependent credits				Design team lacks experience		
	Design team lacks experience				Contractors lack knowledge		
	Budget Constraints						
	Vague requirements						
P	Clients unwilling	Unnecessary credit – Showers		Commissioning is expensive		Calculations for Ventilation	
	Budget constraints					Product-driven	
		Light pollution is difficult		Inconsistency in review		Daylighting is time consuming	
						IAQ management plan contractors lack knowledge	
R	Clients unwilling			Commissioning is elaborate	Manufacturers lack information	Lack of experience – design team	
	Budget constraints						
	Design team lacks experience			Energy modeling is time consuming	Building reuse is elaborate	Daylighting has design problem	
					Building reuse is time consuming		

Research Question 2: How can you modify the evaluation technique to be appropriate for school projects? (Questions 3, 4, 6, 8, 9, 11, 14, 15, 16 & 17)

Participant A: The LEED document should be restructured. Energy being the central atmospheric issue, 60 to 70 points should be allotted to the energy category. Water has to be classified under two sections – potable and non-potable. LEED should not combine them as potable accounts to only 15% of the total water used in the building. LEED should have provisions in its document requirement to allow synergies and inter-blending of credits depending on one another. For example, rain water catchment systems and wet lands have one point each, but if both are used in the project, in theory they contribute as much as five points based on environmental impact. Instead of having clear cut-off requirements, additional points should be given for going beyond the requirement. The points for credits should be in incremental order of performance. The third party commissioning should not be a necessity as the project team should be trusted and it also discourages school projects due to its high budgetary requirements for commissioning. For energy credits the performance of the building should be evaluated after one year of occupancy to be accountable for the credits. For credit on views, if minimum use of glass is mentioned the maximum should also be specified as it has a big impact on the energy and daylighting credits.

Participant B: The extensive calculations in the water efficiency category are required as the participant cannot see any alternative. For the energy and atmosphere category some other software should be made available as there is no need to generate a base case first to compare with your building. The software should assume the base data. As a suggestion to other architects with respect to contractor-related delays, the participant recommends linking the stages of payment in the contract document to fulfillment of the required LEED documents under the contractor's responsibility. Getting information for the recycled content of a material is easy, but specific information about post-consumer content and post-industrial content should be removed from the requirement. If the USGBC takes the initiative to educate the trade organizations on maintaining details about the material composition, the contractors could get the information easily from the manufacturers. The fact that the waste is pulled out of the waste stream should be enough for the USGBC. Its future use is difficult

to determine because the waste management companies themselves are not aware of its final use. They sell the waste materials in bulk. For the systems used in the indoor air quality category, instead of writing the letters and giving detailed breakdowns, the product specifications and layout drawings should be accepted in the submittal. For the IAQ management plan periodically taken photos should be accepted without any descriptive letters.

Participant C: To avoid inconsistency during the audit, the reviewers should be flexible to the possibility of different types of submissions made to fulfill a credit. The brownfield credit should be changed to urban redevelopment as in spirit it is a reuse of a site which was already built on before but without the cumbersome documentation. Since some localities do not have regulations for a parking requirement, LEED should specify a number or define a method of calculation for parking capacity which should be distinguishable between a rural and an urban school.

Participant D: Since contractors have to provide the documents for LEED the specifications handed out to them right at the beginning should enlist the required documents and penalties should be enforced on failure to submit them. A check should be kept on the shop drawings provided by the contractors and the design team has to be forceful with the contractors. All minutes where documentation was discussed should be kept as records. Water efficiency is a highly undervalued category. At least 2 points should be given for every 10% of water reduction and waste water technology should have 3 to 4 points. LEED should be specific about the level of detailing required for documenting commissioning as each commissioning agent has a different method and level of detailing is directly related to the cost of commissioning. LEED has got the architectural and engineering teams on board. Now they have to make the effort at the national level to educate the builder and contractor trade organizations. Each letter template in the LEED excel file should be allowed to be separated out and given to the respective contractors for filling in the details. At present, each contractor has to be given the entire file which sometimes contains confidential information. The easiest method would be to have a website for the project, on which the contractors can fill in the details.

Participant E: The USGBC should contact the school districts who are planning a school project and initiate awareness about LEED among the local public and the funding institutions. In the category of sustainable sites, the extent of site boundary applicable for LEED should be specified. Preferably just the construction site and not the entire geographical site should be included for LEED. For credits like site disturbance, only the construction documents should be enough for the submittal as the as-built drawings are strictly followed on-site. Contractors know their limits and any change contradictory to the drawing is a violation of the contract and liable for penalty. Commissioning, although elaborate, is required. For the materials and resources category, sample documentation should be provided by the USGBC. There could also be an online database of all the green materials used in LEED projects to date. It would reduce the time spent by the design team to survey the market for appropriate materials. The entire process of documentation should be online as towards the end of the project previous documents tend to get lost. Version 2.2 has reduced paperwork to some extent. The USGBC should collaborate with the State to make LEED mandatory.

Participant F: However elaborate the commissioning process, it is required to guarantee a delivery of good work to the client. A third party commissioning agent can better evaluate all the systems for workability. The design team should tie contractor payment to the documentation of materials content. LEED should have credit for the materials used in the electrical and mechanical components. Instead of demanding the dollar value of the recycled content in the material, LEED should accept the percent recycled content. In assembled components like windows getting the dollar value for the recycled content of just the aluminum frame is a difficult task. It is always better to keep a check on the contractors for efficient management of the IAQ plan. The design teams can include narrative, photographs, drawings and specifications for the submittal of innovation credits.

Participant G & H: There should be some initiative taken to educate the private market on the benefits of LEED since the private market is an important component of the building industry. LEED should also define the boundaries for the building project in a multiple building complex so the design team will know the extent of documentation for the site. Goals should be set by LEED to evaluate the building for its environmental performance

instead of setting demanding rigid percentages. The process of meeting the actual numbers requires extensive calculations and a performance based evaluation still maintains the spirit of the credit. Trade-offs should be allowed where the substantially higher achievement of certain credits can compensate for a credit which cannot be obtained.

Participant J: LEED should streamline the documentation process by accepting the same documents which are submitted to the State officials.

Participant K: For a credit such as site disturbance it is best to submit before and after photographs of the construction process to keep the documentation simple. Design teams should completely revamp their specifications to include the requirements for LEED documentation as it significantly reduces problems. The State government should direct the manufacturers to have the details about the materials uploaded on their websites and updated regularly. The manufacturers should also provide the same information to the USGBC, which can be available in a new category for materials database on the LEED website. Additionally, LEED can develop a data template listing the requirements in a ”fill in the blank” type format, which can be handed out to the manufacturers.

Participant L: Mostly there is no problem with the way LEED requires documentation for certification. But LEED could change the points for each credit based on their impact on the environment and the time required to fulfill and document the credit.

Participant M & N: One of the chief lessons learned from the first LEED project was to set project goals and not try to achieve all the LEED credits. The credits should be achievable within the project budget, easy to document, part of the design goals and not utilize excess time. For all the categories it will be helpful if LEED could specify the exact documents required for the submittal. The requirements appear vague when LEED attempts to maintain flexibility. For the water reduction credit it would be better to state the base value to draw comparison for the project. It is best to include all the LEED requirements in the master specifications. The contractors involved in the project are willing to do something new if the necessities are explicitly explained to them. The USGBC should have a technical support team who can provide guidance to the registered project team.

Participant P: In the LEED setup if the nature of the credit is changed it can make documentation easy. Since there is a difference of opinion between the design team and the reviewers, the reviewers should be selected based on their familiarity with the local building codes. For most of the LEED categories getting an experienced team can reduce the problems in documentation. To obtain the exact data for the material content, in the specifications given to the contractors include a ”materials credit data sheet,” so the contractors have to fill in the information as part of the bid. Instead of producing drawings and calculations for the daylighting credit, documents should be accepted in terms of simulation images produced by running radiance software. To make contractors proactive about maintaining records for IAQ management plan, their payments should be tied to providing documents. For innovation credits, study the method of documentation adopted by other design teams and use it as a template. For various products used ask the suppliers to prepare the documentation and submit it with the products. LEED could provide guidelines for documentation and mention the exact requirements which need to be fulfilled. But LEED should maintain flexibility in the documentation process. At present, some credits have examples of the method of documentation. Examples can be provided for all credits which will make the documentation process much simpler.

Participant R: To have fewer problems in documentation, both design and documentation has to be done simultaneously for whichever credit it is possible.

TABLE 8 – CODING RESPONSES FOR RESEARCH QUESTION 2

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
A	Restructure LEED		Portable and non portable categories	Allot 60 to 70 points		Views – Specify maximum limit for glass	
	Allow interblending of credits			Commissioning not necessary			
	Points for incremental order of performance			Evaluate energy after one year of occupancy			
B				Alternate software without a base case	Payments to contractors after providing documents	Accept product specification & layout drawings for systems used	
					Remove classification of post consumer and post industrial waste	IAQ management plan take periodic photos without descriptive letters	
					Educate trade organizations		
					Do not demand end use of waste		
C	Reviewers should be flexible	Brownfield change to Urban Redevelopment					

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
		Specify standard capacity for parking or method for calculating capacity for rural and urban schools					
D	Enlist LEED documents in specifications for contractors		2 points for every 10% water reduction	Specify level of documentation for commissioning	Educate the builder and contractor trade organizations		
	Enforce penalties for contractors to provide documents		3-4 points for waste water technologies				
	Check the contractor's shop drawings						
	Use minutes of meetings for documentation						
	Separate out letter templates in excel sheet						
	Create website for contractors to fill in data						
E	USGBC should	Specify the site			Provide sample		

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
	educate the school districts, local public and funding institutions	Boundaries for projects including infrastructure development			Online green samples database		
	LEED should have online submittal	Site disturbance accept only as-built drawings					
	State Directive to promote LEED	Contractors penalized for violation of drawings					
F					Enforce penalties for contractors to provide materials information	For efficient management of IAQ plan keep a check on the contractors	Include narrative, photographs, drawings, specifications, and narrative for users
					Include materials for mechanical and electrical		
					Accept percent value of recycled content instead of dollar value		
G & H	Educate the private market	Site disturbance					

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
		Submit photographs for initial and completed site conditions					
	Points for incremental order of performance	Specify the site boundaries for projects included in large building complex					
	Instead of achieving all credits allow trade-off						
J	Accept the documents that the state officials accepts for verification						
K	'Fill in the blanks' data template for manufacturers to fill information	For site disturbance show the before and after construction photographs			State directive to manufacturers to upload material contents on website		
					Enlist LEED documents in specifications		
					Approved		

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
					Products database on LEED website provided by manufacturers		
L	Points for level of environmental impact and time required						
M & N	Set credit goals as per budget		For Water reduction state the base standard	LEED Technical support team for guidance	Enlist LEED documents in specifications		
	Specify exact document requirements				Explicitly explain to contractors		
P	Reviewers should have knowledge of local codes				Material credit data sheet given upfront to contractors	For Daylighting run Radiance for simulation and submit images	Study other methods of documentation
	Ask the product suppliers to prepare documentation					VOC – collect information upfront	
	Specify exact document requirements					Enforce penalties for contractors to provide documents	

PARTICIPANT	GENERAL	SUSTAINABLE SITES (3, 4)	WATER EFFICIENCY (6)	ENERGY AND ATMOSPHERE (8, 9)	MATERIALS AND RESOURCES (11)	INDOOR ENVIRONMENTAL QUALITY (14, 15, 16)	INNOVATION AND DESIGN PROCESS (17)
	Provide guidelines for preparing submittal documents						
	Flexibility in documentation						
	Provide examples for documentation						
R	Design and document simultaneously						

Research Question 3: What newer methods of evaluation can be introduced or borrowed for environmentally sensitive schools? (Questions 18 & 19)

Participant A: LEED can incorporate evaluation methods from the North Carolina High Performance Schools Program which requires the same kind of rigor but costs less.

There are public and private schools and both are different from one another. For private schools the clients have control over their project and they can make decisions to include environmental features in their school. But public schools are run by school districts which have to control many schools at a time and putting up any environmental system is a policy issue as it should be applicable to all the schools under their jurisdiction. The LEED reference guide for Schools should adopt a 3D strategy, so that in addition to serving the occupants and being responsive to the environment, it would also be used as a teaching tool for children. An example would be planting various species of plants in accessible wetlands for the kids to study. The building should make an impact on the children to carry these environmental values for the rest of their lives.

Participant B: The USGBC should have a ”Lessons Learned” category on their website or printed editions which includes suggestions from previous LEED applicant teams who share their experiences about the problems they faced, give suggestions to other applicants and present possible cautions for future shortcomings.

Participant C: LEED could convert to a ”Fill in the blanks’” based rating system. This would reduce the inconsistency in the review process and increase the ease of documentation, but it will be less flexible.

For schools, credit should be given to transfer what is physically good for the environment into a teaching tool for the students.

Participant D: LEED can borrow the method of assessment from Green Globes, which is completely online and interactive. LEED has attempted to go online with version 2.2, but it is nowhere close to Green Globes. As Green Globes is a self-assessment rating system, LEED can blend its third party validity with the online assessment method of Green Globes.

Schools, especially public schools, have huge budget constraints as it is public money. The work is also on a tight schedule. The clients and the local residents have to be educated regarding LEED. Some local chapters have taken this initiative, but it has to be done at a national level.

Participant E: LEED and BREEAM are very similar, but LEED should borrow BREEAM's on-site assessment method during the review process.

Food is packed in Styrofoam and brought to school on trucks. There is unnecessary use of non-reusable packing materials and fuel for daily transportation. Instead LEED should promote good sanitized conditions on site to prepare food and serve it fresh to the students. This will also promote local catering jobs. Since many people take the innovation credit for green housekeeping, it can be incorporated as a credit, especially in LEED for schools. LEED should also include a credit for encouraging the children to walk or bicycle to the school as an issue promoting good health. Bus routes can serve the children living far from school. The school should be open to the people of the neighborhood and function as a community center. Even the school yard should double as a play ground for students and a place to promote interaction in the neighborhood.

Participant F: LEED is a comprehensive rating system, but it could borrow the on-site evaluation component from Energy Star. LEED should be seen as a driving tool towards sustainability for professionals, trade organizations, and manufacturers. But in the future LEED will disappear as the responsibility for environmental issues will fall on each individual.

For school projects, emphasis should be placed on the indoor environmental quality and materials and resources to maintain a healthy environment for the young occupants. Teaching LEED goals should be incorporated as an educational component in schools.

Participant G & H: No Response

Participant J: LEED should have an additional category for educational projects. This category should give priority to the environment conducive to the students. LEED should also be considerate about the tight budgets of school projects. School facilities are designed

to last 50 years and the life of renovated school projects are aimed at 20 to 30 years. LEED requirements should be rationalized with the life span of the school projects to avoid any additional capital investment.

Participant K: The ”Maine Energy Efficient Schools” program was developed to promote reductions in electric consumption in schools. It requires the energy model of the building and schedule of electric usage to obtain grants for the project. LEED should accept alternate documents made for programs like Maine Energy Efficient Schools as their requirements are equally rigorous and it saves time by not preparing two different sets of documents.

Participant L: For schools, LEED could integrate environmental issues in the building which are beneficial to the children. A credit could be offered for introducing green housekeeping in schools.

Participant M & N: LEED could refer to Energy Star and Earth Craft, if it is seeking to borrow features from other rating systems.

LEED should have a new category especially for schools where the central focus is on safety, durability and health.

Participant P: LEED can look at CHPS as it is a rating system specifically for schools. It is mainly a self certification system where the advantage is to apply environmental issues within your scope. But the disadvantage is the lack of rigor in implementation due to self-certification. Another rating system is Green Globes for which you provide all the information online and the evaluator comes to your building for evaluation. This could be the best way because it reduces the paperwork to a minimum and the evaluation is on-site.

Participant R: To maintain the credibility of a LEED project, annual or biannual checks should be carried out in the building after it is constructed and occupied. Cradle-to-cradle is an important component of sustainability and it should be incorporated in LEED. The USGBC should set credits in terms of goals. Points should be given in incremental order of achieving percentages towards the goal.

TABLE 9 – CODING RESPONSES OF RESEARCH QUESTION 3

PARTICIPANT	ALTERNATIVES (18)	ADDITIONS FOR SCHOOLS (19)
A	North Carolina High Performance Schools costs less and rigorous	Public schools run by school districts it is a policy issue applicable to all schools under their jurisdiction
		3D strategy – occupancy needs, environmental issues and building as a teaching tool
B	Lessons learned	
C	Fill in the blanks based rating system	Building as a teaching tool
D	Green Globes – online and interactive	Reduce financially demanding issues for schools
		National level initiative through local chapters to educate people regarding LEED and hiring appropriate contractors
E	BREEAM – assessment of site	Promote on-site food services; community involvement in services required by schools
		Green housekeeping
		Promote walking and bicycles to schools
		Schools as a community center for the neighborhood; school yard open to all
F	Energy star – manual onsite rating	IAQ and MR very important for schools
		Incorporate education component in guidelines
G & H		
J		Additional category for educational purpose
		Consideration for low budget projects
		Capital investment in coordination with the typical life of school facility
K	Maine Energy Efficient Schools – for electric consumption	

PARTICIPANT	ALTERNATIVES (18)	ADDITIONS FOR SCHOOLS (19)
L		Educational value – Integration of building process and environmental issues for children
		Green Housekeeping
M & N	Earth craft; Energy Star	Include categories concerned with safety, durability and health
P	CHPS – certify as much as you want but no rigor due to self certification	
	Green Globes – online and manual check after completion	
R	Annual checks	
	Include cradle-to-cradle	
	USGBC – set goals and give points for every level of goal achievement	

Findings

The themes emerging from the summary of responses to research question 1 are presented in ***Table 8***. The findings for each category of LEED were kept separate with a three–tier classification within the category. The barriers in the LEED documentation process, which are voiced very often, are called the ”Key Barriers.” However, some of the issues raised by individual participants cannot be ignored as they might still be relevant. Many of the participants expressed their opinions about LEED, which were not within the scope of this research, but can be used for future research. They are categorized as ”Additional Issues.” Some of the findings have sub-findings as they may not individually cause an impact on the documentation process, but can still influence the key issue. The number of times the issues were expressed by the participants is represented by the ”frequency” column. A summary of these findings will be presented in the next chapter.

TABLE 10 – FINDINGS FOR BARRIERS IN LEED DOCUMENTATION PROCESS

BARRIERS				FREQUENCY
GENERAL	**Key**	1	▪ Clients unwilling	8
			▪ Budget Constraints	10
			▪ Design team lacks experience	3
			▪ Contractors lack knowledge	2
			▪ Time consuming	2
	Unique	1	▪ Unskilled Maintenance staff	1
			▪ Inconsistency in review	1
			▪ Vague requirements	1
	Additional	1	▪ Structure of LEED	4
			a. No points for interdependent credit	2
			b. Verification at end	1
			c. Lacks synergies	1
			d. No incentives	1
SUSTAINABLE SITES	**Key**	2	▪ Brownfield is time consuming; expensive and has ambiguous	4

			requirements ▪ Time consuming – no demarcation of site boundaries and special sites	4
	Unique	2	▪ Cumbersome ▪ Elaborate ▪ Difficulty in Light Pollution credit	1 1 1
	Additional	2	▪ Unnecessary credits ▪ Budget constraints ▪ Conflict with local aesthetics	1 1 1
WATER EFFICIENCY	**Key**	5	▪ Time consuming (product driven and calculations)	4
	Unique	5	▪ Calculations not practical for large buildings ▪ Vague requirements ▪ Cumbersome (product driven)	1 1 1
	Additional	5	▪ Conflict with local building codes ▪ Promotes mediocrity	4 1
ENERGY AND ATMOSPHERE	**Key**	7	▪ Commissioning is expensive – elaborate and time consuming ▪ Energy modeling is expensive – time consuming and requires expertise ▪ Inconsistency in review ▪ Software is cumbersome and accuracy questionable	11 10 2 2
	Unique	7	▪ Product driven	1
	Additional	7	▪ Clients unaware about commissioning	1
MATERIALS AND RESOURCES	**Key**	10 12	▪ Time consuming and cumbersome a. Contractors lack knowledge; hesitant and charge more b. Manufacturers lack information	4 10 5

			c. Inexperienced design team ▪ Building reuse is elaborate and time consuming	3 2
	Unique	10 12	▪ Waste chain untraceable ▪ Cumbersome to include all recycle content with dollar value	1 1
	Additional	10 12	▪ Material cost; credibility and availability ▪ Bid process restrictive of LEED efficiency	3 1
INDOOR ENVIRONMENTAL QUALITY	**Key**	13	▪ Daylighting is expensive and time consuming a. Calculations b. Complexity ▪ Contractors lack knowledge ▪ IAQ management plan is time consuming	7 2 2 3 2
	Unique	13	▪ Calculations for Ventilation is product driven ▪ Lack of experienced design team ▪ Elaborate	1 1 1
	Additional	13	▪ Daylighting has design problems	1
INNOVATION AND DESIGN PROCESS	-	-	▪ Cumbersome essay writing	1

Participant Recommendations

In response to research question 2, the answers from the participants can easily be categorized in two sections – one section has their suggestions to improve the USGBC's documentation process and the second has their advice to other design teams on strategies to be adopted while pursuing a LEED project. Once again the participants had suggestions for improving LEED which do not fit in the scope of this research and they are categorized as "additional suggestions." These are presented below.

TABLE 11 – RECOMMENDED SUGGESTIONS

SUGGESTIONS			
GENERAL	**LEED**	-	▪ Reviewers should be flexible and have knowledge of local codes ▪ Separate out letter templates in excel sheet ▪ Create website for the contractors to fill in data ▪ Online submittal ▪ "Fill in the blanks" data template for manufacturers to fill information ▪ Educate the school districts, local public and funding institutions ▪ Educate the private market ▪ State directive to promote LEED ▪ Accept the documents that the state officials accept for verification ▪ Specify the exact document requirement and provide guidelines for preparing submittal ▪ Provide examples for documentation ▪ Give points for level of environmental impact and time required to document
	Design Team	-	▪ Enlist LEED documents in specifications for contractors ▪ Enforce penalties for contractors to provide documents

			▪ Check contractors' shop drawings ▪ Use minutes of meetings for documentation ▪ Ask the product suppliers to prepare documentation ▪ Set credit goals as per budget ▪ Design and document simultaneously
	Additional	-	▪ Restructure LEED ▪ Allow interblending of credits ▪ Give points for incremental order of performance ▪ Instead of achieving all credits all trade-off
SUSTAINABLE SITES	**LEED**	3 4	▪ Brownfield should be changed to Urban redevelopment ▪ Specify standard capacity for parking or method for calculating capacity for rural and urban schools ▪ Specify the site boundaries for projects including infrastructure development and building that are part of a building complex ▪ For site disturbance accept only the as- built drawings or before and after construction photographs
	Design Team	3 4	▪ Penalize contractors for violation of as- built drawings
WATER EFFICIENCY	**LEED**	6	▪ For water reduction state the base requirement
	Design Team	6	▪ No suggestion
	Additional	6	▪ Divide into potable and non potable categories ▪ Give 2 points for every 10% water reduction ▪ 3-4 points should be allotted for waste water technologies
ENERGY AND ATMOSPHERE	**LEED**	8 9	▪ LEED Technical support team for guidance ▪ Commissioning not necessary ▪ Specify level of documentation for commissioning ▪ Evaluate energy efficiency after one year of occupancy ▪ Alternate software without a base case
	Design	8	▪ No suggestion

	Team	9	
	Additional	8 9	▪ Allot 60 to 70 points for this category
MATERIALS AND RESOURCES	**LEED**	11	▪ Remove classification of post-consumer and post-industrial waste ▪ Accept percent value of recycled content instead of dollar value ▪ Do not demand end use of waste ▪ Online green materials database on LEED website ▪ State directive to manufacturers to upload material contents on website ▪ Educate trade organizations (builders, manufacturers and contractors) ▪ Provide sample documentation
	Design Team	11	▪ Enlist LEED documents in specifications ▪ Enforce penalties for contractors to provide materials information ▪ Explicitly explain to contractors ▪ Give ”material credit data sheet” upfront to contractors
	Additional	11	▪ Include materials for mechanical and electrical
INDOOR ENVIRONMENTAL QUALITY	**LEED**	14 15 16	▪ Accept product specifications and layout drawings for systems used ▪ For IAQ management plan take periodic photos without descriptive letters ▪ For daylighting run Radiance and accept images for submittal
	Design Team	14 15 16	▪ For efficient management of IAQ plan keep a check on contractors ▪ For VOC content collect information upfront ▪ Enforce penalties for contractors who do not provide documents
	Additional	14	▪ For views specify maximum limit for glass

		15 16	
INNOVATION AND DESIGN PROCESS	**Design Team**	-	▪ Include narrative, photographs, drawings, specifications and narrative for users ▪ Study other methods of documentation

To enrich the process of LEED documentation further, the participant responses to research question 3 have alternative methods of evaluation suggested by the participants. They have also recommended certain additions to LEED where school buildings are concerned.

Alternatives and Issues Specific to Schools: Some of the alternative methods of evaluation suggested by the participants will be summarized in the next chapter while discussing the recommendations. A few participants chose to suggest borrowing certain features from other rating systems, whereas others had personal recommendations which they felt would enhance LEED's evaluation process. Suggestions for inclusion of other issues lacking in LEED with respect to schools will also be presented in the recommendations section of the next chapter.

Chapter Summary

This chapter presented the diversity in participant representation with respect to several criteria. It then moved forward to analyze the data collected from the interviews and summarize it around the three research questions. This chapter also consists of the tabulated coding from the first research question responses and the findings for barriers in conforming to the LEED documentation process. Recommendations, as expressed by the participants in response to the second and the third research questions, were also summarized in this chapter.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

Introduction

It is important to understand the impact of the process of documentation on school projects before “LEED for Schools“ is developed and implemented. The views expressed by the architectural and engineering community can be used by the USGBC to make further decisions with respect to improving the methods of evaluation and making them more suitable for school projects.

The purpose of this study was to assess the experiences regarding LEED documentation as expressed by the participants. The study also sought suggestions from the participants to improve the documentation requirements in LEED for schools. The data collected from the participants was analyzed to obtain findings for barriers in the documentation process and to interpret their recommendations for improving it.

Summarizing the Research Findings

The perceptions of a majority of the participants about the barriers in the LEED documentation process are:

- Clients are unwilling to pursue LEED certification for their projects
- Contractors are unaware of LEED documentation requirements and hesitant to carry out documentation
- Design teams have no experience and are not used to the amount of paperwork required in LEED
- LEED documentation requires expertise for services like commissioning and daylighting
- The LEED documentation is a time consuming process with certain credits consuming most of the time (for example: Brownfield, Daylighting, Commissioning, and IAQ management plan)
- LEED documentation process is expensive and not ideal for tight budget projects such as schools
- Some of the requirements for preparing LEED submittals are ambiguous and not self-explanatory
- The level of difficulty in the LEED documentation process is influenced by the type of products or systems used in the project
- The review process during auditing of the document submittal is inconsistent

Besides the major perceptions, some findings were unique and exclusively expressed by individual participants. Each participant had varied experience, hence these unique findings deserve to be mentioned. The perceptions which were unique to certain participants about the barriers in LEED documentation process are:

- Waste Chain of materials saved from being disposed of as waste in the landfills is untraceable as these materials are sold in the open market
- Calculating every single recycled content along with their dollar values is not possible, especially for materials which are part of a product assembly

- Software accuracy is questionable as most of the energy analysis software can be manipulated

- The prescribed calculations for water reduction are not practical for large buildings

- Essay-writing for the innovation credit is a cumbersome process as the technical staff is not experienced with writing persuasive letters

In addition to the major and unique findings, the research also collected findings which comment on LEED in general, but are beyond the scope of this research. They are listed below as additional findings and not included to arrive at any conclusions. These additional findings can be used for future research on LEED:

- Present Structure of LEED does not allow points for inter-dependent credits; it lacks synergies; no incentives are given for going beyond the requirements; and, verification at the end can bring up surprises. *For example, the daylighting credit is dependent on site selection credit. The location of the site, the infrastructure, and the proximity of the neighboring buildings can influence the daylighting credit.*

- Certain credits such as shower stands and alternate fuel station are not ideal for school projects. *Students do not take showers after bicycling to school and installing a alternate fuel station cannot be an individual school decision; it has to be collectively made for all the schools in the district.*

- LEED has no concessions in its setup if the local aesthetics are in conflict with LEED design requirements. *For example, if the local buildings have slate roofs, the school project under consideration has to adopt the same local aesthetics which results in the loss of the heat island effect (roof) credit.*

- In some states the building codes contradict with the credits in the water efficiency category. *For example, for reduction of water consumption, the use of waterless urinals is not allowed in some states or counties. Nor is on-site waste water management acceptable.*

- Green materials are not easily available, making them expensive, and they are too new to have established credibility.

- The bid process for school projects restricts the selection of the right materials. *In a typical public school project at least three contractors have to be invited to bid for a required material. The designers cannot justify awarding a bid based on only the green properties of the material as the other factors like cost, involvement of skilled labor, and contractors' fees, to name a few, are equally important.*

- For daylighting and views credit the maximum usage of glass is not mentioned, although the quantity of the glass façade influences the consumption of energy.

- Clients are unaware of commissioning and it becomes difficult to pursue this credit, especially because it heavily adds to the project budget.

Conclusions

The summary of findings resulted from unstructured and spontaneous responses from the participants. As the final stage of this study, an attempt to derive a relationship between the findings was made in order to understand the sequence, hierarchy, and interdependence of the issues that influence the documentation process in LEED. The conclusion of this study is presented in a bubble diagram, which is also explicitly explained.

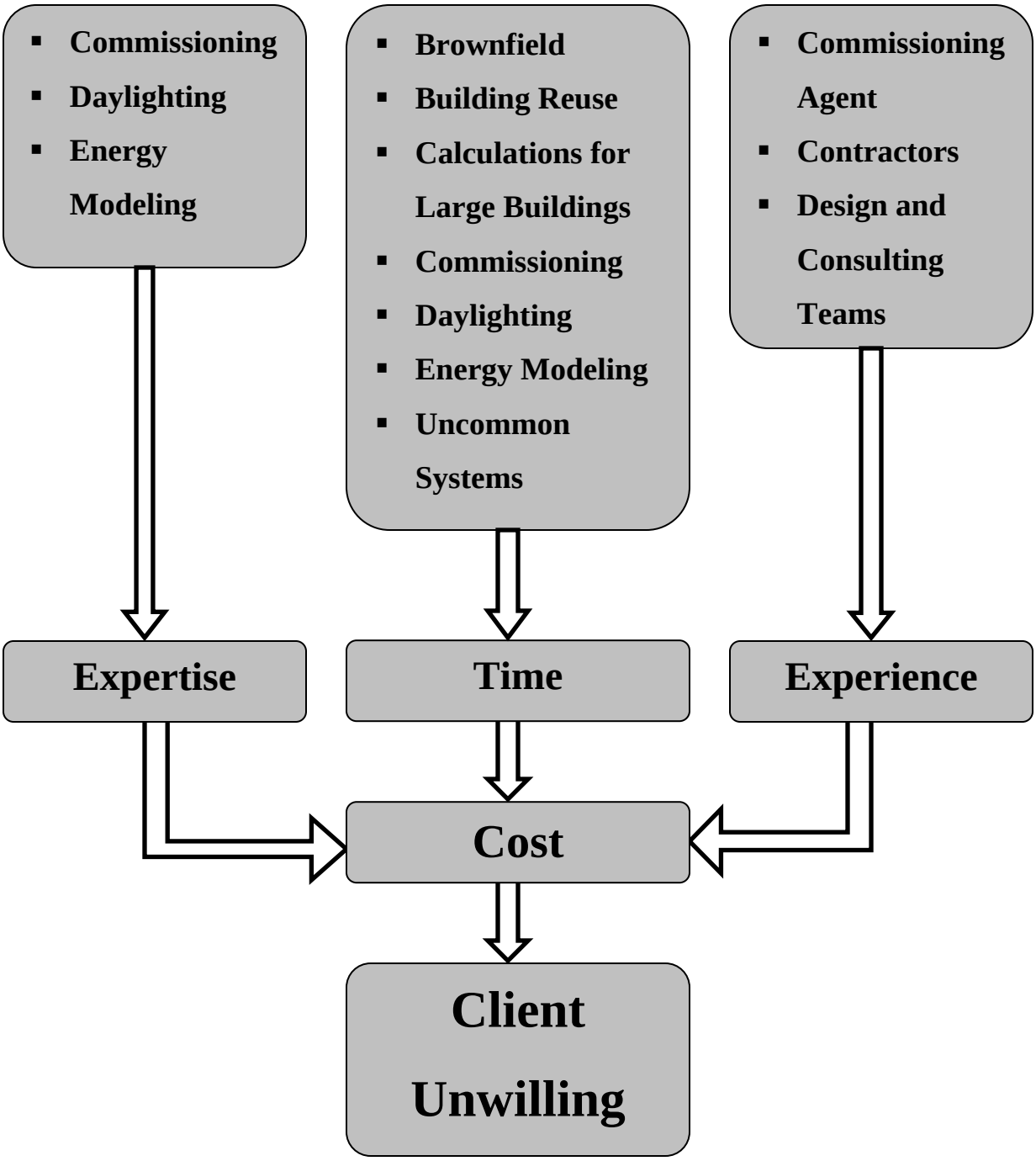

Figure 5.1: Research Conclusion for Barriers in the Process of LEED Documentation

- Commissioning, daylighting, and energy modeling are services which are not adopted in common design and construction practice. These are additional features required for LEED. Due to the exclusivity of these experts, their service is expensive, which is one of the major reasons for the building owners to avoid LEED certification for schools.

- Along with commissioning, daylighting, and energy modeling, documentation for credits such as building reuse, brownfield redevelopment, water reduction calculations for large buildings, and use of uncommon systems are time consuming. Excess time involves additional cost for the services and the delay.

    a. For commissioning, all the systems installed in the building have to be periodically checked and verified for efficiency during and after construction. For LEED a report has to be submitted about the activities carried out under commissioning. The long process of the activities required for commissioning and then documentation makes it a time consuming process.

    b. LEED has provided formulae with data sheets for calculating day light levels. But information has to be filled out separately for each room to get the daylighting level the same. In addition, the external view lines have to be drawn for each of these rooms. Both these process require additional time.

    c. Different software are used for modeling the proposed building for energy efficiency. Initially, there is a to and fro process between the design team and the energy consultants to incorporate energy efficiency proposals in design. Analyzing the building is one aspect of energy modeling, whereas the other aspect is to create a convincing document. This is difficult because not all the performed calculations can be documented.

    d. Developing a brownfield requires reading technical data related to the site. The practice of reading technical data is foreign to a design team and hence requires additional time.

e. The data sheet for calculating water reduction under LEED is not practicably applicable to large buildings and incorporating alternate methods for the section requires time.

f. Adopting a relatively unknown system in the building requires time for the preparation of convincing documents for the LEED submittal, because the reviewers have limited or no information about these systems.

- Since LEED itself is a new rating system, professionals from the building industry are not entirely acquainted with LEED. Most of the time the design team is going for LEED certification for the first time and faces problems due to lack of experience. Although more and more design and consultancy firms are becoming proactive, the problem still lies in the lack of knowledge amongst the contractors about the requirements and work commitments for LEED. Since LEED requires additional efforts from the design and the consulting teams, they include an additional fee for adopting LEED and preparing the submittal, and the contractors overbid as they are unaware of the commitments for LEED.

- Scarcity of expertise for exclusive services, time required for preparing LEED submittal, and lack of knowledge of the project team, individually and collectively add to the cost of the project, which is not acceptable to school project clients. School projects have tight budgets because the money for the project comes from the tax payers. School committees are very cautious about using this money for LEED, which is believed to be an unjustified cost.

Recommendations

There are several recommendations that participants made. Chapter four has the entire list of those recommendations which are categorized into recommendations for LEED improvement, recommendations to fellow design teams, and suggested alternatives for school projects. These recommendations are summarized in this chapter.

Participants' recommendations for LEED improvement

- The USGBC should initiate awareness among the School districts to adopt LEED. Design teams want to adopt LEED, but the cautiousness of the school districts in accepting LEED is a deterrent.
- Another method of promoting LEED is to have a State directive to adopt LEED.
- LEED should remodel the point system. Instead of giving one point for each credit, the points should be based on two criteria – level of environmental impact of the credit and time required to document it.
- Since LEED requirements are not clearly stated, the reviewers should be flexible with respect to the documents submitted and preferably have knowledge of the local codes to be aware if LEED will be in conflict with the local codes.
- The documents required for State submittal are rigorous and LEED should accept them as it reduces the time involved in duplication of documentation.
- The credit for Brownfield development should be addressed as Urban Redevelopment. Doing this would maintain the spirit of the credit but save the design team the effort of reading through technical data for documentation.
- Not all local codes specify the parking capacity for schools. It becomes convenient while documenting to have a standard base parking capacity specified by LEED.
- Not all sites have a defined boundary. Most public school projects include both the infrastructure as well as the building development. New building construction in a campus also does not have a distinct site boundary. LEED should state a method to demarcate the site for the purpose of documentation.
- Contractors have to follow the "As-built drawings" on site and they face penalties for activities not stated on these drawings. Hence, this set of drawings issued on site should be enough evidence for the Site disturbance credit submittal.

- For calculating the proposed water reduction for the project, LEED should state the typical base level water utilization for a school project.

- Commissioning is not required for school projects and, if required, LEED should specify the extent of commissioning as presently the requirement is ambiguously stated.

- Instead of demanding the energy analysis results of the building, evaluate the building for its energy efficiency after a year of occupancy. This can reduce the extensive analysis of the building during the design stage, hence reducing time and expense. To reduce the time further, software should be developed which already has the base case installed in it and saves duplication time.

- To make it easier for the design team to collect the documents required for the LEED submittal, the USGBC should create a project website on which the contractors can fill in the required data; and "fill-in-the-blank" type of letter templates should be developed by the USGBC which can be handed out to the manufacturers for collecting information.

- LEED should provide Technical support to the project teams.

Participants' recommendations for fellow design teams

As a method of learning from their mistakes and sharing lessons learned, the participants in this study took the opportunity to provide guidance to other design firms wanting to register their projects for LEED. Their suggestions were mainly with respect to the process of documentation and practices adopted to get the documents and the completed work from the contractors.

Contractors

- The design team should enlist the required LEED documents in the master specifications with penalties associated with them.

- Prepare a “Materials data sheet” which lists the required information on materials and give it upfront to contractors, so they are aware of the type of information they have to collect from the manufacturers.

- Keep a check on the contractors and their shop drawings at the beginning to avoid potential conflicts with LEED requirements.

- To reduce the design team’s workload, ask the product suppliers to provide documents which can be part of the LEED submittal.

Documentation

- Design and document simultaneously. Documents may get lost during the course of the project if not documented on time.

- Do not try to achieve all the credits. Review the credits and decide on the ones that can be achieved under the available budget.

- Documents provided in the LEED submittal could be in terms of narrative writings, photographs, drawings, specifications, and minutes of meetings.

Alternatives Suggested for LEED

Participants suggested alternative rating systems for USGBC to review their method of evaluation. They suggested at least one unique quality of each of these rating systems that can be incorporated into LEED.

- North Carolina High Performance Schools – This rating system is as rigorous as LEED in terms of evaluation, but it costs less.

- Green Globes – This is one of the latest rating systems which should be reviewed by the USGBC for its online method of documentation and the interactive nature of the software.

- BREEAM and Energy Star – LEED could include an on-site assessment component similar to these rating systems.

In addition to adopting features from other rating systems, participants also suggested publishing a book or uploading a category on the website which has information provided by experienced design teams. This book or category can be referred to as “Lessons Learned.” Yet another suggestion was to convert LEED into a ”Fill-in-the-blanks: type rating system to reduce documentation.

Suggestions Specific to Schools

- When the credits are designed specially for schools, LEED should aim for 3D effect in the credit system which includes catering to the needs of the occupants, designing the building in consciousness to the environment, and using the elements in the building as a teaching tool for students.

- Since schools are generally low budget projects, LEED should give priority to this aspect while designing credits for school projects.

- LEED should promote certain additional categories for school projects such as, preparing and providing food on the school premises as it saves the cost of transportation, promotes local employment, and reduces inorganic waste due to the packaging of food; green housekeeping as it is essential to maintain a healthy environment for the young occupants; emphasising using green building materials; promoting walking or bicycling to schools to increase physical activity among the students; and promoting the use of the school premises as a community center for the neighborhood and keeping the school yard open to public beyond the school’s operational time.

- Educate the school districts, funding institutions, and tax-payers on the benefits of LEED certification.

Research Recommendations

The research recommendations were derived based on the participants’ recommendations. The factors influencing the research recommendations are the frequency of repetition of the recommendation, the uniqueness of the recommendation, and the

professional qualification of the participant putting forth a suggestion (example – an architect or an engineer or a consultant), amongst other factors.

This study showed that the architectural and engineering communities have come forward to adopt LEED. Although they are the vital members of the project team, to make LEED successful other members of the project team should also be brought on board. These people would include the developers, contractors, suppliers, and manufacturers. Most of the participants in this study found the lack of contractor knowledge about LEED to be a major setback in the process of documentation as their active involvement is essential. Hence, the USGBC has to reach out to these members of the project team. Most of the contractors or manufacturers represent national level organizations. If the USGBC reaches out to these national organizations they can carry the effort further to increase awareness among their members with respect to LEED. It could be a *trickle down* effect. Like one participant said, "*LEED has achieved the first stage of getting their own people, namely the architects and the engineers on board; the next stage is to get along the remaining project team*".

Even if the entire project team adopts LEED, the financing to pursue it has to come from the clients. While promoting LEED for Schools, one of the essential components is to understand the flow of finances in school projects. Schools are managed by school districts, which run more than a single school. When a new school project is proposed a committee is formed to plan the school. The design team has to be in contact with this committee for the proposed school project. The design team can propose registering the project for LEED, but the committee which is the client, is often hesitant to adopt it as it requires additional expenses and the committee is answerable to the school district for proposing additional budgetary allotments. The school district is not the owner of the money itself, but it is the taxpayers' money and hence the district representatives are highly cautious with this money. The true clients here are the taxpayers – the residents of the area. The USGBC should develop a network of local chapters who can meet the residents of a locality where a school is proposed and encourage them to adopt LEED. Instead of trying to first involve the school committee, then the district, and finally residents, the reverse order might be an easier option.

As a second level effort, the USGBC can go further and introduce pilot school projects in several areas which could pioneer a change for schools in neighboring districts. But the present requirements under LEED are financially not feasible for most school projects. Initially, to promote LEED, the USGBC can relax a few financially demanding credits and eventually, when more school districts start adopting LEED, those credits can be recalled.

To begin with, LEED for Schools" should be paperless. All information should be accepted online and the review of the project should be based on its performance. For this purpose the building should be reviewed on-site only after it has been occupied for a year.

To promote LEED, the USGBC should restructure itself. There should be departments created within the USGBC – a research team to study new trends and incorporate them in the guidelines and documentation methods; a technical team to manage the online version of LEED; a review team for conducting on-site evaluation of the building; a technical support team to provide guidance during the course of the project; a market survey team to look for new materials and products available in the market and upload the information on the USGBC website; and a promotional tram to mobilize the local chapters and guide them to promote LEED.

Further Discussions

This study, like many other studies, did have its share of limitations. The profile of the participants in CHAPTER 4 shows that the participant representation was concentrated more on the eastern coast of the U.S. A similar study could be conducted with participants from the regions with lesser representation.

All the participants in the survey were architects or engineers or consultants related to school projects registered or certified with LEED. Many of these participants raised their concerns about the lack of knowledge of the contractors and manufacturers and the unwillingness of the clients to register for LEED. This research may serve better it the opinions and the needs of the contractors and manufacturers and the school authorities is obtained.

During the course of this research LEED 2.2 was released. This version has gone online, but not many participants could comment about it as not many were aware of the details of the new version. So, this study consciously avoided references to LEED version 2.2. But, when the design teams are better aware of the latest version of LEED, a better picture of its advantages and disadvantages can be obtained and studies can be conducted to improve it further.

Some participants had extreme views. An example for this is the demand to make LEED mandatory to save the trouble of convincing the clients and educating the contractors among other problems. Although this study does not recommend mandating LEED, there could be reasons which many others may have to support the effort of mandating LEED.

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BREEAM http://www.breeam.org/schools.html

http://www.bre.co.uk/schools/section.jsp?sid=483

BREEAM School Manuals

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CHPS Best Practice Manuals for Schools

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http://www.greenglobes.com/

Books Basic Inquiry of Quantitative Research by Dr. R. Ouyang

Research Methods Knowledge Base by William M. Trochim, Cornell University

Making Sense of Qualitative Data: Complementary Research Strategies
by Amanda Coffey, Paul Atkinson

APPENDICES

APPENDIX A QUESTIONNAIRES

QUESTIONNAIRE 1

On a scale of -3 to 3, rate the level of ease or difficulty in documenting the credits, where -3 = very easy, 3 = very difficult and 0 = neutral

TABLE 12 – RATING SCALE FOR DOCUMENTING CREDITS

SUSTAINABLE SITES								
Site Selection	-3	-2	-1	0	1	2	3	n/a
Development Density	-3	-2	-1	0	1	2	3	n/a
Brownfield Redevelopment	-3	-2	-1	0	1	2	3	n/a
Alt. Transportation (Public Transportation Access)	-3	-2	-1	0	1	2	3	n/a
Alt. Transportation (Bicycle Storage and Changing Rooms)	-3	-2	-1	0	1	2	3	n/a
Alt. Transportation (Alternative Fuel Vehicles)	-3	-2	-1	0	1	2	3	n/a
Alt. Transportation (Parking Capacity)	-3	-2	-1	0	1	2	3	n/a

Reduced Site Disturbance (Protect or Restore Open Space)	-3 -2 -1 0 1 2 3 n/a
Reduced Site Disturbance (Development Footprint)	-3 -2 -1 0 1 2 3 n/a
Stormwater Management (Rate and Quantity)	-3 -2 -1 0 1 2 3 n/a
Stormwater Management (Treatment)	-3 -2 -1 0 1 2 3 n/a
Heat Island Effect (Non-Roof)	-3 -2 -1 0 1 2 3 n/a
Heat Island Effect (Roof)	-3 -2 -1 0 1 2 3 n/a
Light Pollution Reduction	-3 -2 -1 0 1 2 3 n/a
WATER EFFICIENCY	
Water Efficient Landscaping (50% Reduction)	-3 -2 -1 0 1 2 3 n/a
Water Efficient Landscaping (100% Reduction)	-3 -2 -1 0 1 2 3 n/a
Innovative Wastewater Technologies	-3 -2 -1 0 1 2 3 n/a
Water Use Reduction (20% Reduction)	-3 -2 -1 0 1 2 3 n/a
Water Use Reduction (40% Reduction)	-3 -2 -1 0 1 2 3 n/a
ENERGY AND ATMOSPHERE	
Fundamental Building Systems Commissioning	-3 -2 -1 0 1 2 3 n/a
Minimum Energy Performance	-3 -2 -1 0 1 2 3 n/a
CFC Reduction in HVAC&R Equipment	-3 -2 -1 0 1 2 3 n/a
Optimize Energy Performance	-3 -2 -1 0 1 2 3 n/a
Renewable Energy (5%)	-3 -2 -1 0 1 2 3 n/a
Renewable Energy (10%)	-3 -2 -1 0 1 2 3 n/a
Renewable Energy (20%)	-3 -2 -1 0 1 2 3 n/a
Additional Commissioning	-3 -2 -1 0 1 2 3 n/a

Ozone Protection	-3	-2	-1	0	1	2	3	n/a
Measurement & Verification	-3	-2	-1	0	1	2	3	n/a
Green Power	-3	-2	-1	0	1	2	3	n/a
MATERIALS & RESOURCES								
Storage & Collection of Recyclables	-3	-2	-1	0	1	2	3	n/a
Building Reuse	-3	-2	-1	0	1	2	3	n/a
Construction Waste Management	-3	-2	-1	0	1	2	3	n/a
Resource Reuse	-3	-2	-1	0	1	2	3	n/a
Recycled Content	-3	-2	-1	0	1	2	3	n/a
Regional Materials	-3	-2	-1	0	1	2	3	n/a
Rapidly Renewable Materials	-3	-2	-1	0	1	2	3	n/a
MR Certified Wood	-3	-2	-1	0	1	2	3	n/a
INDOOR ENVIRONMENTAL QUALITY								
Minimum IAQ Performance	-3	-2	-1	0	1	2	3	n/a
Environmental Tobacco Smoke (ETS) Control	-3	-2	-1	0	1	2	3	n/a
Carbon Dioxide (CO2) Monitoring	-3	-2	-1	0	1	2	3	n/a
Ventilation Effectiveness	-3	-2	-1	0	1	2	3	n/a
Construction IAQ Management Plan (During Construction)	-3	-2	-1	0	1	2	3	n/a
Construction IAQ Management Plan (Construction IAQ Management Plan)	-3	-2	-1	0	1	2	3	n/a
Low-Emitting Materials	-3	-2	-1	0	1	2	3	n/a
Indoor Chemical & Pollutant Source Control	-3	-2	-1	0	1	2	3	n/a

Controllability of Systems	-3	-2	-1	0	1	2	3	n/a
Thermal Comfort (Compliance with ASHRAE 55-1992)	-3	-2	-1	0	1	2	3	n/a
Thermal Comfort (Permanent Monitoring System)	-3	-2	-1	0	1	2	3	n/a
Daylight and Views (Daylight 75% of Spaces)	-3	-2	-1	0	1	2	3	n/a
Daylight and Views (Views for 90% of Spaces)	-3	-2	-1	0	1	2	3	n/a

QUESTIONNAIRE 2 – INTERVIEW

Introductory Question

1. It is observed that not all registered school projects actually complete the certification process. What, according to you, could be the reasons?

Sustainable Sites

2. Sustainable Sites being the very first category in LEED, can you recollect the initial stage setbacks you faced while documenting this category?
3. As a category concerned with the planning stage of a project, what kind of flexibility do you think should be incorporated in its documentation process?
4. In your opinion, how should a credit like site disturbance, which spans over the entire life of the project, be documented?

Water Efficiency

5. What problems were faced by the people involved in documenting the credits under water efficiency?
6. According to you, what should be the approach for evaluating the credits in this category?

Energy and Atmosphere

7. What concerns did you have while preparing the documents for this category, which requires extensive calculations, simulations and documentation?
8. If you think that the documentation for commissioning credits is elaborate, what are your suggestions to simplify them?
9. Given an opportunity to modify the evaluation method for this category, what would be your technique? *(quantum of documents, time for calculations)*

Materials & Resources

10. Could you narrate the problems you faced while conducting the market survey and investigations in the material selection process?
11. What method would you suggest should be adopted for evaluating the material selection credits?

12. What difficulties did you encounter while documenting the additional activities required for the reuse of an existing building?

Indoor Environmental Quality

13. What were the limitations you faced while preparing the submittal for the systems used under this category?
14. What modification do you think is required in documenting the credits which require after-completion field tests?
15. How do you suggest the IAQ management activities during construction should be documented?
16. According to you how should one document a credit like day-lighting which involves both design and technical strategy?

Innovation & Design Process

17. Since you had a chance to adopt your own method to document the credits under this category, what was that technique?

Concluding questions

18. Can you think of any evaluation techniques that can be borrowed from other rating systems to further enhance the usability of LEED guidelines? (*Not necessarily other environmentally rating systems only)*
19. Do you have any suggestions for the method of evaluation that were not covered in this questionnaire?

APPENDIX B CORRESPONDENCE

REQUEST FOR PARTICIPATION

To,

Mr. / Ms. XXX

I would like to introduce myself as Dr. Jim Jones, Director for the Center for the High Performance Learning Environments (CHPLE) and Associate Professor in the College of Architecture and Urban Studies (CAUS) at Virginia Tech. The CHPLE is a nationally recognized center that seeks to improve the design and operation of K through 12 learning environments. The CHPLE investigates issues such as the interactions between pedagogical models, learning technologies and the architectural space, and the appropriateness of the environmental design strategies such as the US Green Building council's LEED (Leadership in Energy and Environmental Design) guidelines.

Currently, one of our research agendas is concerned with understanding the appropriateness of LEED for schools. Through a series of targeted surveys, interviews and case studies with architects who have been involved with schools designed with LEED certification as a goal, we hope to better understand when and where LEED is appropriate or not for schools. We also hope to improve our understanding of the operational barriers to

architectural practice and environmental design strategies where LEED is involved. The results of these studies will be used to develop design guidelines and identify the evaluation procedure barriers to the design process of new innovative learning environments.

Since you/your firm have/has demonstrated an interest in environmental design and LEED through your architectural/consulting practice, I would appreciate your involvement in the study by participating in an interview. It is only with help and participation from knowledgeable professionals such as yourself that our goals can be met. While I fully understand that your time is valuable, your contribution is immeasurable.

As part of the Master of Science program at Virginia Tech, Madhulika Pise is currently working with CHPLE in realizing its goals. She will correspond with you to arrange for a ½ hour face-to-face or telephonic interview at your most suitable time during the first 2 weeks of January. The interview would consist of open-ended and demographic questions relating to your experiences with LEED documentation procedures.

Your involvement in the study is highly valuable to us and I request you to kindly spare some time to help us find solutions to improve the design and performance of K through 12 schools.

Thank you

Sincerely,
Dr. Jim Jones

With Regards,
Madhulika Pise
Graduate Student
M.S. Architecture
(Building Sciences)
CAUS, Virginia Tech

CONFIRMATION OF PARTICIPATION

Dear Mr. / Ms. XXX,

As I recollect. you consented, through an email, to participate in our LEED for Schools survey. At present we have entered into the second phase of our study. In this phase we would like to listen to your opinions and suggestions about the documentation process for LEED certification. This will be done through a telephonic interview with you and it will last for approximately 30 minutes. This being the most important phase of our research, your participation now will be highly appreciated, even if you were not able to participate in the previous phase of our survey. The interview will have approximately 10 to 18 questions and it will be audio-recorded. I shall send a copy of the interview questions for your reference two days before the scheduled interview day.

Since the interview will be audio-recorded, the Institutional Review Board of Virginia Tech requires that you sign the Informed Consent Form. I am attaching the form with this email. Please read the form thoroughly and only then sign it. I cannot proceed with the interview unless I have the signed form with me.

Along with the consent form I am also attaching the “Demographic questions” which asks you to rate the level of difficulty in documenting each LEED credit. It would reduce the duration of the interview if I receive the replies for these questions before the interview. In that case I would not need to ask you questions related to the credits you did not opt for. You can fax the "Informed Consent Form" and the "Demographical Questions" or scan and email it to me. The details for the fax are included in the attached file.

Kindly let me know what time and days between Jan 10th to 17th, 2006, are most suitable to you for the interview. I shall send a confirmation email with the exact time and day accordingly. It would be helpful if you could mention the telephone number at which I should call you.

I would like to thank you once again for your participation in our study. It is most encouraging for us.

Thank you

With Regards,
Madhulika Pise
Graduate Student
M.S. Architecture
(Building Sciences)
CAUS, Virginia Tech

APPENDIX C *IRB APPROVAL SUBMITTAL

INFORMED CONSENT FORM

Virginia Polytechnic Institute and State University

Informed Consent for Participants in Research Project Involving Human Subjects

Title of Project: LEED Documentation Process: Implementation Barriers for School Projects .

Investigator: Ms. Madhulika Pise

Faculty Advisor: Dr. James Jones

I. Purpose of this Research

The purpose of this study is to develop adaptable techniques for evaluation of design guidelines for innovative learning environments as the current LEED practices do not sufficiently support the design of new K through 12 school buildings. The Center for High

***NOTE:** 'IRB' is the abbreviation for Institutional Review Board.

Performance Learning Environments (CHPLE) at College of Architecture and Urban Studies (CAUS), Virginia Tech seeks to improve the design of K through 12 learning environments through a series of targeted case studies and interviews of architects, school authorities and teachers. Through these interviews, issues related to the implementation of environmental design principles in schools will be identified and be used to develop guidelines and evaluation methods for the design of environmentally sound schools.

II. Procedures

A questionnaire will be forwarded to the participants before the interview. The researcher will conduct a phone or face-to-face interview with participating architects. Each interview will last between 30 to 45 minutes. The face-to-face interviews will take place in an environment that is agreed upon and comfortable to both participant and researcher, and is guaranteed to protect the participant's privacy. Each interview will be audio recorded, and transcribed by the research group member who conducted the interview. Transcripts of interviews will be coded and analyzed to identify emerging themes. Every effort will be made to keep all information collected from all participants confidential.

III. Risks

Participants will be asked to describe and discuss previous events that took place during their job experiences. This could possibly cause feelings of discomfort if an unpleasant experience is being described. Risk to participants will be not greater than would occur during typical daily activities. The researcher promises to take all possible measures to eliminate this minimal risk during the course of the study. Participants will have full freedom to stop the interview or withdraw from the study at any point. Each participant will have full access to his/her case of the study and the opportunity to preview the final research output as well as providing feedback to the researcher at any point during the course of the study.

IV. Benefits

No promise or guarantees of benefits are offered from the researcher to any of the participants. Participants in this study will possibly benefit from the opportunity of reflecting upon their professional experiences involved with the educational facility.

On the scale of the built environment, issues related to the implementation of environmental design principles in schools will be identified. The results of this study will be used to develop better techniques for evaluating design guidelines for new innovative learning environments.

V. Confidentiality and Anonymity

Every effort will be made to hold all information collected from all participants confidential. All interviews will be audio recorded. Pseudonyms will be used throughout the interview process. Audio files and transcriptions of interviews will be stored in secure locations by the researcher. These materials will only be accessible to the members of the research group and the faculty advisor. Audio files and transcriptions will be destroyed when research involving these items is deemed complete by the research group.

VI. Compensation

The participants will receive no compensation for their participation in this study.

VII. Freedom to Withdraw

Participants will have full freedom to stop the interview or withdraw from the study at any point without penalty. Participants are free not to answer any interview questions that they choose.

There may be situations where the investigator may determine that a participant should not continue to be involved in the study.

VIII. Approval of Research

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University.

IRB Approval Date: 09/01/2005

IRB Approval Expiration Date: 09/01/2006

IX. Subject's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

1. To participate in a 30-45 minutes interview.
2. Provide feedback regarding the transcript of my interview to the research group if needed.
3. I understand that the interview will be audio recorded.

X. Subject Permission

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

Subject Signature _____ Date_____

Should I have any questions about this research or its conduct, I may contact:

Investigator(s) Telephone/E-mail:

Madhulika Pise	Ph: (540)808-7035	email: likapise@vt.edu

Advisor Telephone/E-mail:

Dr. James Jones	Ph: (540)231-7647	email: wolverine@vt.edu

Departmental Reviewer/ Department Head Telephone/e-mail:

Robert Schubert	Ph: (540)231 5607	email: silver@vt.edu

Chair, IRB Telephone/e-mail:

David M. Moore	Ph: (540)231-4991	email:moored@vt.edu

Subjects must be given a complete copy (or duplicate original) of the signed Informed Consent.

PROTOCOL FOR IRB APPROVAL

Investigators: Ms. Madhulika Pise

Advisor: Dr. James Jones

Title: Evaluation Procedures in Leadership, Energy and Environmental Design for new K through 12 Schools.

Justification of Project

The Center for High Performance Learning Environments (CHPLE) in College of Architecture and Urban Studies, Virginia Tech seeks to improve the design of K through 12 learning environments through a series of targeted surveys and case studies and interview of architects. Through these interviews, issues related to the evaluation procedures of environmental design principles such as LEED guidelines, in new K through 12 school buildings will be identified, as the current LEED practice of evaluation is are not sufficiently supportive of school designs.

The survey, case study and interview investigations will be based on the following primary objectives:

1. The barriers to the implementation of environmental design principles including Leadership in Energy and Environmental Design (LEED) procedures to new public schools will be identified.

2. Suggestions for altering current LEED procedures to issues specific to K through 12 schools will be developed.

3. The LEED procedural barriers to architectural design procedures that seek to implement environmental design principles including LEED procedures to schools will be identified.

4. Suggestions for new design procedures and evaluation techniques will be developed.

The outcome of this research is intended:

- For the innovation in design procedures with adaptable evaluation techniques under LEED.

- The qualitative deductions will then be presented to the LEED for Schools committee for implementing the results in the new LEED for Schools Reference Guide.

Procedures

The research will be conducted in two phases with a sample group comprising of architects who have designed LEED certified schools along with architects who have good and environmentally efficient school projects to their credit.

The participants were selected, in part, with collaboration from the Council for Educational Facility Planners International (CEFPI), the US Department of Energy's Energy Smart Schools program and from the list of schools registered with the US Green Building Council (USGBC).

A participation request letter was drafted and was sent out through an email to the prospective participants. A list of the confirmed participants is included in Appendix A. The names of the prospective participants are included in Appendix 'B'. The request letter is included in Appendix C.

Phase I:

This would involve the collection of data from the participants through survey questions. The survey will be uploaded on the CHPLE website and then the web-link for the same will be forwarded to the participants. A password will be created for accessing the survey and it

will be sent through an email to each participant separately. The survey will be filled out electronically after the participant has fully read, understood and signed the Informed Consent Form. It will be an objective survey. The completed questionnaire will be accessible only to the investigators and the faculty advisor. The time to fill out the survey is expected to last about 45 to 60 minutes. The web-based questionnaire is included in Appendix 'D'.

The deductions from the phase I survey will be used to frame more descriptive questions for phase II. These questions are dependent upon the data analyses from the Phase I.

Phase II:

This phase will involve interviewing the same sample of architects. The approval for conducting the interviews would be sent out electronically to the respective architectural firms and would be reported to the Virginia Tech IRB.

The interview will take place either over the phone or will be conducted face-to-face at the participant's office or the educational facility designed by the participant and in an environment that is agreed upon and comfortable to both participant and researcher, and is guaranteed to protect the participant's privacy. Interviews will be conducted during normal work hour. It will last 30 to 45 minutes. Only questions relevant to the stated objectives will be asked. The semi-structured questions developed for the sample group, are shown in Appendix D. Further feedback might be required from participants as the research develops. The interviews will be audio-tape-recorded and transcribed by the researcher.

In addition to interviews, study visits to the schools may also be conducted. This will involve observing the building and recording photographic images of the physical form of the building without the presence of the occupants.

Risks and Benefits

The interviews and case studies would have very minimal risks for the participants. Participants will be asked to describe and discuss previous events that took place during their job experiences. These events might involve interactions with other human subjects or the utilization of the educational facility that is the subject of interest. This could possibly cause

feelings of discomfort if an unpleasant experience is being described. The researchers are committed to taking all possible measures to eliminate this minimal risk during the course of the study. Participants will have full freedom to stop the interview or withdraw from the study at any point. Each participant will have full access to his/her case of the study and the opportunity to preview the final research output as well as providing feedback to the researcher at any point during the course of the study.

Participants in this study will benefit from the opportunity of reflecting upon their diverse experiences with educational facilities. On the scale of the built environment, issues related to the implementation of environmental design principles in schools will be identified. The results of this study will be used to simplify the evaluation and documentation procedures for new innovative learning environments' design guidelines.

No guarantees of benefits are offered from the researcher to any of the participants.

Confidentiality/Anonymity

All information collected from all participants will be confidential. All interviews will be audio tape-recorded, and the tapes will be considered a primary data source. The researcher will be responsible of recording one interview with each participant and transcribing the interview. It is possible that the researchers might request feedback from the participant during later phases of the study, if necessary. Pseudonyms will be used to protect the participants' identity.

Tapes and transcripts of interviews will be stored in secure locations by the researcher. These materials will only be accessible to the researchers and advisory committee members upon request. Tapes and transcripts will be destroyed when research involving these items is deemed complete by the researcher and the academic program.

The researchers will take all measures to guarantee that this study will not, in any case, affect the participant's current job or position. The researchers will be forced to break confidentiality if any abuse incidents are known or strongly suspected or if the participant is believed to be a threat to himself /herself or others.

Bibliography for IRB Submittal

Appendix A – List of Confirmed Participants

Appendix B – List of Prospective Participants

Appendix C – Request Form for Participation

Appendix D – Web-based Survey and Semi-Structured Interview Questions Informed Consent Form

VITA

Madhulika Pise
1203 Snyder Lane
#1000G
Blacksburg, VA 24060
likapise@vt.edu

EDUCATION

2006 M.S. Architecture (Building Sciences), College of Architecture and Urban Studies, Virginia Tech.

2002 Diploma in Advanced Architectural CAD, Cadd Center - India, Autodesk authorized.

2000 Bachelor of Architecture, Kamala Raheja Vidyanidhi Institute of Architecture, University of Mumbai.
Thesis: Integrating a *Self-Rejuvenating Alternative Health-care Center* into the reorganization of the urban fabric around a densely populated temple complex.

EXPERIENCE

Smithgroup Inc. Intern Architect Apr 2006 – Present

Healthcare

- Involved in renovation and addition for Medical Hospital in University of Virginia.

International Association For Women In Architecture Jan 2005 – Feb 2006

Documentation

- Organizing all the original drawings and documents of an architect's entire professional life into simplified categories.

Hosmac India Pvt. Ltd. Project Architect Dec 2003 - July 2004

Health-care

- Involved in all stages of design, construction and commissioning of hospital projects, which mainly included Multi-specialty and Orthopedic hospitals.

Shilpa + Pinkish Shah Architects Project Architect Jan 2002 - Sept 2003

Institutions & Interiors

- Worked at various stages of design and construction for a K-12 school sports wing, an addition to an existing historical school building, and a new dormitory building in a university campus.

Chhaya + Chhaya Design Consultants Asst. Architect May 2000 - May 2001

Museum & Tourist Center

- Worked as a team member on a winning competition proposal for Ajanta Tourist Complex, which was designed as a prelude to the prestigious World Heritage Site of Ajanta Caves – a collaborative effort of Govt. of India and Govt. of Japan.

Hospitality

- Produced execution drawings, coordinated architectural and engineering drawings as part of a team designing and executing 5-star grade hotels for the State Govt. of Kerala in India.

Adarkar Associates Intern Architect Dec 1999 - Mar 2000

Landscape & Sustainability

- Designed unconventional play equipments out of non-rusting industrial waste materials for a children's park in a coastal town in India.

PROFESSIONAL AFFILIATIONS

- Appearing for **LEED** accreditation exam
- Registered - Council of Architects, India